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BRITAIN AND THE ATOMIC BOMB

We have always tried to give full coverage to the news and opinions on atomic energy originiating in other countries. In continuation of this policy, we print in this issue a memorandum on atomic energy control prepared by the British Association of Scientific Workers, and an article by Professor N. F. Mott, distinguished physicist and chairman of the British Atomic Scientists' Association.

These two documents agree on certain important conclusions which run contrary to prevailing American opinion. The demand for compromise is the more significant because it reaches us through channels that have heretofore regarded atomic energy problems from somewhat divergent points of view.

The British Association of Scientific Workers, an affiliate of the British Council of Trade Unions, has believed that the Soviet proposals of June 11 are well meant and provide a basis for an efficient system of inspection of national atomic energy development by international agents. They thus proclaim that a compromise between the original U. S. and U.S.S.R. plans has been achieved in practice by the latest Soviet concessions, and call for the immediate implementation of this compromise.

The British Association of Atomic Scientists, on the other hand, has given whole-hearted support to the Lilienthal plan (even if a few phrases from the Association's memorandum on atomic energy negotiations, taken out of context, have been quoted by Gromyko and more recently by Vishinsky, in support of the Soviet point of view). Although the British Atomic Scientists' Association publishes Professor Mott's article with a warning that he does not speak for the organization, it is significant that the chairman of such a group, even if writing as an individual, calls for a compromise on the basis of the Soviet inspection proposals.

Professor Mott argues that, with U.S.-U.S.S.R. relations as they are, neither of the "big two" can be expected to leave the management of its own atomic energy installations to an international body in which the other may have a dominant influence.

Under these conditions, the only practicable way of preventing an all-out atomic armaments race is, according to Professor Mott, to establish effective international inspection which would make sure that no alarming stockpiling of atomic explosives is taking place in any single country. Professor Mott thinks that the degree of security which can be achieved by such inspection is high enough for America to pay for it with the dismantling of her bombs, relaxation of secrecy in nuclear science, and even large reconstruction loans to the U.S.S.R.

It may be argued that Professor Mott's pessimism goes too far. For example, he neglects the majority proposal embodied in the second report of the UN Commission, that production quotas shall be agreed upon in the convention establishing the international control agency (rather than left at the discretion of the Agency), and the Soviet endorsement of this proposal, which shows that an overall international regulation of the extent of national atomic energy developments may prove acceptable to both sides.

This readiness to settle for even less control than can perhaps be achieved underscores the strong British desire for compromise and the consequent reluctance to follow the official American policy of insistence on the ownership and management features of the present control plan.

The reasons for the British attitude are easily discernible. The memorandum of the Association of Scientific Workers quotes the "War Department Thinking on the Atomic Bomb", the semi-official exposé published in the BULLETIN (see Vol. 3, No. 6) to the effect that the role of European allies of the U. S. in a future war will be to "provide a cushion of time". The memorandum clearly implies the reluctance of Britain to accept the role of such an "atomic bomb cushion".

Professor Mott, too, refers to the War Department document and says: "In alliance with America, nothing that that country will do would save us if war should break out against a power capable of occupying the Channel ports and equipped with atomic bombs. Fifty of those missiles, launched with V-2 weapons in the present state of development, could kill a quarter of the population of London and make the city uninhabitable." Discussing whether it will help Britain to have atomic bombs of its own for possible retaliation, Professor Mott says, "The Russians could do us more harm with ten bombs than we could do to them with a hundred."

These two statements of British attitude call for some general comments on American foreign policy. Many American atomic scientists view this policy with grave apprehension, because it seems to them to lack full appreciation of the fundamental changes in the strategic situation and world-political relationships produced by the atomic bomb, guided missiles and biological warfare. (There is little satisfaction in the fact that the policy of the U.S.S.R. shows even less understanding of the "atomic age".)

Our present policy toward the Soviet Union seems to be to utilize the period of post-war weakness of the Soviet Union to restore the economic strength and the military potency of Western Europe to a level which would make it immune to communist influence from inside and capable of withstanding an attempted military encroachment from outside. If a war between the Soviet Union and the Western block should then occur, this war apparently is envisaged as a repetition of the first world war—with the nations of Western Europe providing and holding a bridgehead for the deployment of the forces of America and the British Commonwealth.

Western Europe proved to be much too small, crowded and vulnerable to serve for this purpose even in the second world war. Some European leaders may think of reversing the situation in a third world war and successfully "defending Western civilization" at the line dividing the East and the West even if the countries behind this line will be crumbling under the burst of atomic bombs; but can they be certain that their nations will uphold this stand?

It may be argued that even in the last war, courageous, unreasonable stands by nations, who refused to acknowledge the objective hopelessness of their situation, proved a better guarantee of national survival than the more rational policy of bowing to overwhelming force to avoid bodily destruction of the country; but this might have been the last chance for Western civilization to display the spirit of Thermopylae and Verdun. Atomic bombs and guided missiles have reduced to mockery the concept of a death stand barring the foe from the nations' homes.

Facing the future realistically, we must anticipate that even after the economic balance of European countries is restored and a modicum of prosperity re-established, after their armies are re-created and trained with American weapons, these nations, including England, will not constitute a military counter-balance to the Soviet Union.

Missiles carrying atomic warheads or germs will threaten these nations with complete obliteration if they attempt to fulfill the function of "cushions" which some of our strategists want to assign to them. Under these conditions, it is likely that the overwhelming desire of the peoples of Europe will be to avoid participation in any future war. Not even a Churchill may be able to rally Englishmen to defy the enemy if this enemy is ready to rain hundreds of atomic bombs on English cities.

This does not mean that we should cease our assistance in the reconstruction of Western Europe or even cynically decide that, since in the case of war all European economy is likely to fall into Russian hands, our interest lies in keeping this economy as disrupted as possible. We might, however, be deceiving ourselves if we believe that by this assistance, we are forging a chain of military alliances which would shield us, at least for a while, in a war with the Soviet Union. Helping European nations to get on their feet is an enlightened and noble policy; it should not be debased by suggestions that the restored nations may serve as our "atomic bomb cushions". Stripped of this unworthy and unrealistic motive, this policy makes full and real sense as a step towards peaceful reconstruction of the world which can be achieved only by a large-scale settlement with Russia.

Whatever we may think of the Soviet political system, however understandable may be our indignation at the suspicion and abuse heaped on us by the Soviet propaganda machine, we must not forget that without such a settlement, the policy of European alliances whether its slogan is "balance" or "unbalance" of power, cannot permanently help us in our quest for peace and security.

E. R.

ERRATUM

In the editorial in the October issue of the BULLETIN, the word "not" was omitted from the quotation in the last two lines on page 281, thus reversing the meaning of the sentence, which should read "many scientists believe that this will be *not* too great a sacrifice to pay for for security against atomic warfare".

INTERNATIONAL CONTROL: THE CHOICE BEFORE THIS COUNTRY

N. F. Mott

The BULLETIN is indebted to the British Atomic Scientists' Association for permission to reprint the following article from the ATOMIC SCIENTISTS NEWS, Vol. 1, No. 3. The author is Professor of Theoretical Physics at the University of Bristol and is chairman of the British Atomic Scientists' Association.

In the autumn of 1947 it is idle to pretend that the chances of obtaining international control of atomic energy in the near future are good. Nevertheless it remains as important as ever to work for international control, even though success will take much longer to achieve than appeared possible two years ago. It is therefore necessary for us in the Atomic Scientists' Association to consider what steps can be taken which will make the attainment of some part of our aim less unlikely. Unfortunately we must also define our views on the policy that should be followed by this country if, as appears only too probable, no system of control is set up in the next few years. Consideration of these two issues is the purpose of this article.

PRIMARY AIM IS PEACE

Let us at the outset be clear that the aim of our policy is to prevent war. It is not simply to abolish atomic bombs while retaining other weapons; we do not believe that this is possible, because atomic weapons are so effective that they would almost certainly be used in a conflict between great powers, if their use would give a clear advantage to either side. Atomic weapons are relevant to the problem of the abolition of war for two reasons; the first is that their widespread use in a major conflict is likely to be so destructive to both sides taking part that it has become even more important to avoid war than it was before; the second is the common interest that all countries have for avoiding atomic warfare, which may well act as a powerful incentive for doing something to avoid it.

We, in this vulnerable and densely populated country, have as great an interest in peace as any other people; in calling for a crusade for international control among the people of Britain the Association would therefore be preaching to the converted.

REFUSAL TO WORK NOT A SOLUTION

It is not a crusade that is called for at present, so much as hard thought about the steps that ought to be taken, together with much educational work to bring home to the country the true facts. But before giving an analysis of the position and suggesting certain steps, it will be well to dispose of one course of action which any officer of the Association and indeed any scientist must have heard proposed scores of times. This is that scientists hold the key to world peace in their hands, and that if they refused to work on atomic energy or on atomic weapons the governments would not be able to make this kind of war. This is undoubtedly true; but in fact the scientists of England and America are no more likely to behave in this way in times of national danger than are the men of the armed forces, or the makers of munitions; as for the scientists in Russia, we have almost no contact with them, and cannot tell what they would do, but we can guess that their behavior would be the same. Refusal to work on atomic or other weapons is a course which some men take as a result of their views on right and wrong; it is a course which, if adopted by a large number of men in this country, might have some political influence, but which does not seem certain to make war less probable.

PRESENT POSITION OF INTERNATIONAL CONTROL

The Lilienthal report on the control of atomic energy was rightly welcomed in this country as a great and inspiring document, and its acceptance by the American State Department as the basis of their proposals to the Atomic Energy Commission of the United Nations seemed to many of us a real step forward in the history of statesmanship. It will be well to recall the outstanding points in the report. These are:

(a) That an international "Atomic Development Authority" should be set up which should own all uranium mines and all power plants capable of making fissile materials (the raw materials of the bomb) in dangerous amounts.

(b) That the Authority should carry out research and development in atomic energy, in order that it should offer an attractive career to first class scientists; without this it would be impossible to exercise effective control.

(c) That the Authority should have powers of inspection, to ensure that no government was making fissile material secretly.

In their plans or dreams for the distant future, most members of the Association still feel strongly that a constructive scheme of this kind is to be aimed at, and that its setting up would represent an achievement of the first order for world peace. In considering short term or immediate

steps, also, it is necessary to have an ultimate aim in view, and this the Lilienthal scheme provides. But unfortunately agreement on this scheme appears at the moment most unlikely. The reason for this is, of course, the friction between the United States and Great Britain on the one hand and the U.S.S.R. on the other, which is the outstanding fact in the world situation today. Therefore any immediate proposals for the control of atomic energy must be made with a view to lessening this friction, especially because it is only in an eventual conflict between these powers that there is any serious risk of the use of atomic bombs in the next few decades.

TWO BLOCS MUST BE RECONCILED

In any plan for control, therefore, which involves some renunciation of national sovereignty such as is implied by ownership by the Authority of mines and factories, a situation must be envisaged in which either the United States or else the U.S.S.R. is asked to obey a decision of the Authority on some vital matter. For instance, according to the proposals of the Lilienthal report, the A.D.A. would have to decide on the allocation of raw materials (uranium) and on the distribution of piles between the countries concerned. It is clear that the U.S.S.R., whether justifiably or not, regards the world as being split fairly sharply into countries favorable to them, and countries grouped round the United States. It is therefore hopeless to expect their government to accept as binding any decision of an international body on such vital matters. The United States would take the same view if the number of states voting consistently with the U.S.S.R. exceeded the number voting for them. This point of view has been expressed by Mr. Gromyko himself, who said: "The Soviet Union is aware that there will be a majority in the control organ which may take one-sided decisions, a majority on whose benevolent attitude towards the Soviet Union the Soviet people cannot count. Therefore the Soviet Union, and probably not only the Soviet Union, cannot allow that the fate of its national economy be handed over to this organ."[1]

With the world divided into two blocs, then, an international body is likely to reach decisions only if the men and women who form part of it owe loyalty to it, rather than to their sovereign states. We may hope that such loyalties may arise in the future. At present they do not exist. It follows, therefore, that at the moment it is futile to advocate the setting up of one authority which will control the activities both of the U.S.S.R. and of the U.S.A., either in atomic energy or anything else. No body can be envisaged whose impartiality and justice the governments of the two countries would trust. Therefore the effort to be spent in each country on atomic energy and the location and type of plant must be left to the national governments concerned, and we must regretfully admit that any attempt to have it otherwise will not succeed in the present state of the world.

If this analysis of the situation is correct, it appears that the divergence between the Soviet viewpoint and the American proposals put forward by Baruch will not easily be bridged. The American statesmen and scientists have put great emphasis on complete control and this is more than the Russians can accept. Nevertheless, it is still true that the only realistic policy for this country is to try to reconcile the viewpoints of America and Russia; the following very tentative suggestions are made to suggest how this might be begun.

STEPS TO AN INTERNATIONAL AUTHORITY

If the concept of control is left out of the Lilienthal scheme, there remain two things; the idea of an international body of scientists charged with the development of atomic energy, and the proposals for inspection. It seems possible that with this residue something of value can be built up. Let us consider the question of inspection first. On this the attitude of the Soviet statesmen has been by no means uniformly hostile, although we can be sure that they would not admit inspectors without very great inducements. It cannot be denied that the admission of inspectors would decrease the military strength of the U.S.S.R. Under present conditions little is known of their new centers of heavy industry beyond the Urals, or of the state of their atomic research. Inspectors who were nationals of a foreign power would obtain such knowledge, which would be of undoubted value to the chiefs of staff of the foreign power concerned.

From the American point of view the outstanding fact in the situation is that the discovery of the bomb will abolish in a few years' time the security of their homeland from sudden attack. The bomb for them, in the 1950's, is like the development of aviation was for us in the 1930's. This has been realized by American public opinion. Therefore there is widespread demand for security through control and inspection, and willingness to surrender perhaps even some degree of national sovereignty to obtain it.

It would probably not now be agreed by most Americans that by inspection alone any worthwhile security could be obtained. Nevertheless it seems to the writer that along lines such as these resides the best hope, even if at the moment it appears only a small hope, of bringing about a reconciliation between the points of view of America and Russia. Let us suppose that there were established in various countries, including these two, laboratories for research on atomic energy in each of which outstanding scientists from the western and eastern powers would be invited to work. Let us suppose also that the governments concerned would undertake to give representatives of these laboratories access to their mines and plants sufficient to ensure that no unreasonable stockpiles of fissile material were being made. In this way America, and for that matter Russia, could have access to information that would show them that no preparations for sudden attack were being made. The resulting lessening of suspicion could be very great. In fact the degree of security obtained would not be much less than under a full-fledged Lilienthal plan even armed with the abolition of the veto, for in no case is there anything to prevent a great power, dissatisfied with the decision of the Security Council, from disregarding its order and seizing such plants as exist on its territory and starting to make bombs. It must always be remembered that, with the balance of power as it is today, no sanctions can be applied against America or Russia without involving the world in a major war.[2]

1 BULLETIN, Vol. 3; No. 7, p. 190.

2 See, for instance, Professor Blackett's pamphlet, "The Atom and the Charter" (A. Sc.W. and Fabian Society, 1946.)

It will be argued also that the inspectors or scientists in Russia would be hedged around by so many restrictions that they would be unable to obtain the information that the rest of the world would desire. It is of course true that no scheme will succeed if the governments concerned are determined that it shall not. We have to decide whether, in the present state of the world, it is worth making any proposals at all.

Any scheme for the international control of atomic energy, set down coldly in black and white, looks unattainable in the present world of suspicion and power politics. Nevertheless, in the writer's view, it is necessary to make proposals for such schemes, because in atomic energy the world is confronted by a new situation. These proposals are put forward as basis for discussion in the belief that they form the minimum that would do any good, and that they should be put before American public opinion. It is only America that can make an offer along these lines. What the Russians would demand in exchange it would be for them to say. They might ask for the cessation of stockpiling of fissile materials, the outlawing of bombs, for technical information or even for a dollar loan. The issue could only be settled by hard bargaining between the two countries.

IF NO AGREEMENT IS REACHED

If no agreement is reached between America and Russia, we may envisage that Russia will continue to make every effort to manufacture atomic bombs and to obtain favorably disposed governments in the states on her borders. In America the development of atomic weapons will continue, with its accompaniment—the militarization of science and the imposition of secrecy on a greater and greater proportion of their research. In addition, the importance of overseas island bases for the United States will increase. The time is still far distant when Russia and the United States can attack each other from home bases with automatic weapons of the V2 type, and for attacks with piloted aircraft, bases near the objective will be important to avoid prohibitive losses. These points are well brought out in two recent semi-official articles on United States Navy and War Department thinking on the atomic bomb.[3] Both for offensive and defensive purposes, the value to both sides of allies and bases distant from the homeland will be very great, as a sort of screen or cushion that will absorb the first shock of an atomic war.

POLICY FOR THIS COUNTRY

In this situation, what should be the policy of this country? It is not the role of the Atomic Scientists' Association to advise on whether we should ally ourselves with America, whether we should attempt to form a western European bloc or whether we should attempt to follow an independent course in friendship with Russia. Some facts may, however, be pointed out. In alliance with America, nothing that that country could do would save us *if* war should break out against a power capable of occupying the channel ports and equipped with atomic bombs. Fifty of these missiles, launched with V2 weapons in the present state of development, could kill a quarter of the population of London and make the city uninhabitable. An alliance would, from the point of view of this country, have value only in the hope that its deterrent effect would be great enough to prevent war—to establish a pax Americana.[4] As recently pointed out in an article in the BULLETIN OF ATOMIC SCIENTISTS,[5] the deterrent effect will only be great if the alliance remains strongly armed with atomic weapons and with a highly developed passive defense, with all that that implies in interference with the life and liberties of the countries concerned.

Whether or not we favor the American alliance, there are certain decisions in the more limited field of atomic energy which will have to be taken by this country. At the present time large sums of money are being spent by the Ministry of Supply in the development of atomic energy at Harwell and the North of England. This can be justified on three grounds:

(a) That invention of chain-reacting piles is a revolutionary scientific discovery of immense importance, and that it is essential to develop them in this country, in order that we may keep our scientific pre-eminence with all that that implies for our industrial development. The provision of strong sources of neutron radiation and of tracer elements would alone justify some development.

(b) That atomic energy offers us hope of a substantial addition to our fuel supplies, at a date in the future which is difficult to predict and on which various authorities give conflicting estimates.

(c) That in a few years' time we shall be able to make atomic bombs.

STOCK OF PLUTONIUM OR PRODUCTION OF POWER

In the development of any project for atomic energy, the initial steps that must be taken will not depend on which of these ultimate aims is in view; certain technical problems must be solved and a large pile built. It is safe to say that the time has not yet come when any definite decision must be taken. But it will come in this country soon enough. It will come in particular when the first pile begins to produce fissile material (plutonium) in significant quantities. What is then to be done with this plutonium? Two courses are open to us. We can store it up in underground places, ready for use in bombs if need arose, and concentrate all our energies in building more piles to produce more and more of the material. Or alternatively we can devote all our energies to the production of power. In this case the plutonium will be fed back into a different design of pile where in the end it will be used up, and we shall never accumulate a large store. These two courses involve somewhat different engineering projects; there is a real choice before us. The decision is one that the government will have to make after considering the views of its political, military and scientific advisers. The military, whose duty it is to state the requirements for defense in the event of a war, are almost certain to urge the manufacture of bombs. If the majority of scientists decide that they are opposed to this policy, they must oppose it actively and secure national support.

[3] BULLETIN, Vol. 3, Nos. 6 and 7.

[4] See article, H. C. Urey, *ibid*, Vol. 3, No. 6.

[5] Morrison and Wilson, *ibid*, Vol. 3, No. 7.

Some general arguments that can be put forward for accumulating bombs are as follows: If we had some we could threaten retaliation against any power that might use them against us; they would strengthen the hand of the Foreign Secretary in international affairs; they are the weapon of a great power, and if we do not have them we renounce our position as a great power. These are all arguments connected with prestige.

The following reasons can be put forward against the policy of making bombs: The only countries against whom we could either use or threaten the use of atomic bombs in the foreseeable future are the U.S.S.R. or possibly a resurgent Germany which could only come into being as a threat to us under Russian influence. Now it is entirely unrealistic to suppose that we can even consider atomic warfare with Russia with any chance of success without full American support. Even on the doubtful assumption that we would have a greater supply of bombs, we are infinitely more vulnerable. The Russians could do us more harm with ten bombs than we could do to them with a hundred. But if we have an alliance with America, it is obviously preferable for military reasons that bomb production should be concentrated in their less vulnerable continent just as it was in the war which has just ended. This is almost certain to be the view of the Americans themselves.

But suppose that we do not have an alliance with America, either because we cannot have one on acceptable terms, or because an alternative policy proves preferable. We have to ask whether atomic bombs would be of any value to us then. We have again to face the fact that any power occupying the continent and possessing atomic bombs is in a position to destroy us. In that case, what should our defense policy be? Clearly it should be designed so that no power should have much to gain by attacking us, but that any power attempting to occupy our country (perhaps to use as a base or deny the use of our territory to an enemy) will lose heavily in the attempt. If we had atomic bombs, we could say that if attacked we could retaliate on such cities of the enemy as were accessible, though probably we could not do much harm to centers behind the Urals. Also atomic bombs could be a very effective weapon against any attempt at seaborne invasion involving the use of harbors. These are sound military reasons for possessing bombs. The reasons against possessing them are less tangible, but none the less real. One of them is that, at some not too distant date, when the technical information we had from America before 1945 is no longer of importance, our project for atomic energy could cease to be secret. It could be carried out in collaboration with the countries of Western Europe and indeed with any country that was willing to work in the open. We could let it be known that we were making no stockpile of bombs with which to attack anyone, and we could give the Russians and everyone else the opportunity to come and see that this was so. We could attempt to make atomic energy a field for collaboration between the nations instead of a source of suspicion.

Citizens of this country may well have to decide which of these policies is the right one; whether the moral lead which the peaceful and open development of atomic energy would give outweighs the confession of military weakness which it entails. Such matters cannot be decided on scientific grounds alone. It is the duty of the A.S.A., representing the informed opinion of scientists in this country, to state the facts on which a decision must be taken.

BRITISH ASSOCIATION OF SCIENTIFIC WORKERS ANALYZES THE DEADLOCK

In August the Executive Committee of the Association of Scientific Workers of Great Britain issued a memorandum on the International Control of Atomic Energy. A condensed version of this analysis follows.

A great deal of pessimism seems to be felt on all sides concerning the discussions on the international control of atomic energy...

It is the opinion of the Executive Committee of the Association of Scientific Workers that the facts do not warrant such a pessimistic interpretation. We believe that the recent statement of the position of the U.S.S.R., made...on June 11, makes it clear that on most issues the position of the U.S.S.R. differs but little from that of the U.S.A., and we think that acceptable compromises on the remaining points at issue between the two Governments could be worked out, given the will on both sides...

'Perfect' Security for all Nations is not Obtainable—In seeking an agreed solution on the control of atomic energy the idea that a completely watertight system of security against atomic weapons can be worked out must be avoided. Perfectionism is just as illusory in this field as in any other field of international relations. ...This stand against perfectionism leads us to reject schemes of controlling atomic energy based on some form of World Government....International control...cannot be allowed to await the setting up of a World Government.

No International Agreement is Possible without the Adherence of both the U.S.A. and the U.S.S.R.—The point of view is now being canvassed . . . that if agreement with the U.S.S.R. on an international control scheme based on the Baruch proposals should prove to be impossible, the other nations should...set up their own control scheme and then if, within a specified time limit, the U.S.S.R. has not joined, that nation should be branded as an aggressor and sanctions invoked against her....We wish to warn against the grave consequences of a scheme such as this. If one part of the world has an agreement on atomic energy this is likely to operate as a military alliance directed at the rest of the world...

A Wide Measure of Agreement Exists Already— . . . All countries are agreed on the urgent necessity of

an international control scheme. All countries agree that when such a scheme is functioning no atomic weapons should be in the hands of any national authority. All agree that the international control authority should have its own rules of procedure and that there should be no right of veto in the day to day functioning of the authority. All agree that the international control authority should have its own inspection staff which should be chosen on an international principle and have full inspection rights in any establishment in any country concerned with obtaining atomic war materials and producing atomic materials and atomic energy. All agree that the international control authority should be empowered to conduct special investigation on cases when it is suspected that illicit material is being produced. ...All agree that the international control authority must have the positive functions of operating research establishments staffed by its own qualified international personnel....

In view of this wide measure of agreement it is our opinion that a start should be made by setting up an international control organ having powers on which there is immediate agreement.

The Points of Disagreement can be Adjusted by Compromise . . . Outlawing Atomic Weapons — The Soviet Union insists that a primary requisite for any scheme of control is a convention outlawing the military uses of atomic weapons in all circumstances. Such a convention appears to us to be highly desirable and it is difficult to justify the reluctance on the part of Great Britain and the U.S.A. to agree to it. Perhaps such a convention should be amended in such a way as to outlaw the military use of atomic weapons in all circumstances except by the United Nations Organization in retaliation against a nation that has used them in some future military action....

Dismantling Stocks — The Soviet Union also requires that in the initial stages of any control scheme, all countries should dismantle their existing stocks of atomic weapons and cease the production of the new ones. Such a provision appears, on the face of it to be eminently reasonable.... In practice, however, the only nation likely to possess any appreciable stock of atomic weapons for some years to come is the United States and it is not unnatural that before destroying her own stocks, she would need to be convinced that no other country was engaging in the clandestine manufacture of such weapons. We feel that a compromise on this question is possible along the lines that America should turn over her present stocks of bombs to the United Nations, on the understanding that if at a later date it could be shown that another nation was engaged in the clandestine manufacture of atomic weapons, the U.S.A. should have the right to resume exclusive possession of the bombs she had handed to the United Nations....In the meantime no more bombs would be produced....

International Control — . . . The idea of international ownership of atomic energy was one of the provisions of the original Lilienthal plan which appealed to many scientists because it helped to give the international authority a constructive... role. Such a provision, however desirable, is by no means essential... and the reasons for the doubts expressed by the U.S.S.R. regarding such international ownership can be understood.

In the future, atomic energy may become a key factor in the economic life of nations....Spokesmen of the U.S.A. have never hidden their desire to maintain or restore a system of "free private enterprise" over as large a portion of the earth's surface as possible. Socialist Russia is naturally anxious that any international system of the control of atomic energy should not make possible the use of the economic power of atomic energy for this purpose. We are of the opinion that a Britain committed to a planned Socialist economy would be quite entitled to similar misgivings. Furthermore, it is not difficult to envisage a state of affairs in the future where the U.S.A. might itself wish to ensure that this economic power is not used in the opposite way, viz., to establish a socialist economy in a part of the world at present living under a capitalist economy....It may well be that when a system of international control of atomic energy is operating effectively on a narrower scale, much of the suspicion that it would use its powers restrictively or for political ends might disappear. If that is the case, international ownership or managerial control might be added later....

Inspection — The American plan envisages that the international inspectors should have unlimited rights of passage in any country and should be able to go anywhere to satisfy themselves there is no clandestine manufacture of atomic weapons. The U.S.S.R. supports the idea of international inspection, but has made it clear that this must not become equivalent to an elaborate system of spying. The attitude of both sides on this issue is understandable. The Americans wish to be quite sure that if they cease manufacturing atomic weapons no other country is doing so secretly. On the other hand, against the possession of the atomic bomb by one country the most effective defense in the hands of the U.S.S.R. lies in the fact that the disposition of its industry is largely unknown to other powers....We believe this is another case where a compromise will have to be reached and it is essential that each side should understand the reasons behind the hesitation of the other side....

We support the suggestion made by the British Atomic Scientists' Association that on the presentation of *prima facie* evidence to the Atomic Energy Commission of violation of the Atomic Energy Agreement, the Atomic Energy Commission should issue a search warrant empowering its inspectors to enter a specified region of a town or country to search for illicit plants....Apart from this procedure...the international inspectors would be free to inspect only duly recognized atomic energy plants or mining establishments which each nation would be required to declare...

Unanimity Rule—...We feel that the same arguments which make the unanimity rule essential in the case of sanctions in general, apply with at least equal force in the case of sanctions for violations of the atomic agreement[1]. . . The most important argument is that sanctions could not be invoked against either the U.S.A. or the U.S.S.R. without a major war ensuing....

Moreover, at the present time it is quite inconceivable that the U.S.S.R. would agree to the waiving of the unanimity rule....She regards the unanimity rule as the most important safeguard that the United Nations Organization will not become a mech-

[1] See the article by P. M. S. Blackett in BULLETIN, vol. I, no. 8.]

anism whereby the majority imposes its will on her in every important issue....

Secrecy in Atomic Research—... Even at this stage before the conclusion of an international agreement we believe it essential that the secrecy restrictions be lifted over all fields covering fundamental phenomena or the industrial and medical applications. It appears to us that secrecy with respect to military applications is alone justifiable at present....

Agreement Would be Easier if Framework of Negotiations were Extended—...Since America is the only country producing fissionable material, the concessions she makes in the field of the production of atomic weapons could not be matched by concessions by other powers that would be considered by the American electorate to compensate her. If, however, the whole field of disarmament were brought into the question, agreement should be easier since, with the U.S.S.R. possessing the greatest army in the world, concessions in the field of atomic energy could be matched by concessions in other fields....

We feel very disappointed that the role taken by the United Kingdom in the discussions on the control of atomic energy has been almost entirely negative....A much more positive approach from this country is called for. In particular the view must be avoided that effective international control can only be achieved through a control scheme identical in all its main features with the Baruch proposals.

While. . .the institution of an effective control scheme does not depend wholly, or mainly, on this country, no country has a greater stake in seeing that such a scheme is instituted at the earliest possible moment. In a recent official report prepared by the U.S. War Department[2]...the importance of American allies is seen as providing a "cushion of time"...in a future war....Suggestions that our country should act as an "atomic cushion"...serve only to underline our vital interest in the matter.

As a constructive contribution. . . we urge the immediate declaration that this country intends immediately to lift the secrecy from all aspects of atomic energy research except those related directly to military security...

[2] See BULLETIN, Vol. 3 No. 6.

LIFTING THE BAN ON EXPORT OF TRACERS

G. Hevesy

We have received the following comment upon the recent decision to export isotopes for research. Professor Hevesy holds a joint appointment as Professor of Physical Chemistry at the University of Stockholm and the University of Copenhagen.

The 5th of September was a happy day for all workers in the field of atomic tracers outside the United States. On that day, President Truman lifted the ban on the export of radioactive products produced by the pile.

In the first application of artificially radioactive isotopes as indicators, which followed shortly after Joliot-Curie's discovery of artificially produced radioactivity, substances were used which were prepared by applying neutrons emitted from a mixture of a radium salt or radium emanation with beryllium powder. The utilization of 1 g of radium in the irradiation of carbon disulfide, for example, produced ^{32}P having an activity of about 3 microcuries.

While such an activity was found to be useful in numerous studies of phosphorus metabolism in plant and animal organisms and also in such investigations as the determination of the amount of blood circulating in the human organism, much larger activities were required in other types of biological research. Cyclotron-produced samples having activities of several millicuries became available a few years later. Due to the great generosity of Professor Ernest Lawrence and his helpful staff, including Dr. Aebersold, Dr. Kamen, the late Dr. Ruben and others, several workers outside the United States obtained cyclotron products. It is not without interest that technicium (element 43) was discovered in Palermo by Segré in molybdenum samples irradiated at Berkeley and shipped to Sicily.

By the entry of the United States into the war, the supplying of isotopes to foreign countries was stopped. The bombs thrown at Pearl Harbor not only scuttled battleships; they frustrated some of the tracer work which would have been performed outside the United States as well.

After the end of the war, foreign tracer workers were in a much less favorable position than they were previous to it. Pile-produced radioactive isotopes were only infrequently prepared in the United States by means of the cyclotron. The export of pile-produced products being prohibited, and cyclotron-produced products becoming more scarce, foreign workers were almost completely deprived of tracers made in the United States.

In view of the large amounts of radioactive isotopes produced at Oak Ridge, and the fact that the isotopes of main interest in biological research cannot be used to any dangerous purpose, it was hoped that these would be made available for export. President Truman's most happy decision to lift the ban on the export of these products of the Atomic Energy Commission fulfilled such hopes. This is a fitting occasion to express the feeling of gratitude and admiration of European workers to their colleagues overseas for their most remarkable efforts, their ingenuity and tenacity, which have made it possible that, only 13 years after the discovery of artificial radioactivity, the newly discovered substances have become available in unexpectedly great amounts and concentrations to research workers.

SECURITY REGULATIONS IN THE FIELD OF NUCLEAR RESEARCH

Bart J. Bok, Francis Friedman and Victor Weisskopf

The Committee on Science and Its Social Relations of the International Council of Scientific Unions requested Dr. Bok and Dr. Weisskopf to prepare for the United States "A Report on National Legislation on Atomic Energy and on the Prohibition of Unauthorized Communications or Information on Certain Subjects of Scientific Investigation". With the aid of Dr. Friedman they combined a statement of official procedure with the critical comments of research scientists. Dr. Bok is Associate Director of the Harvard University Observatory. Dr. Friedman and Dr. Weisskopf are members of the Physics Department of the Massachusetts Institute of Technology.

As the initial step in preparing a report for the Committee on Science and its Social Relations a letter was addressed by Dr. Bok to Mr. David E. Lilienthal, chairman of the U.S. Atomic Energy Commission, requesting a brief statement about policies relating to the general subject of atomic research.

Dr. Detlev W. Bronk, chairman of the National Research Council, kindly offered to transmit this letter to Mr. Lilienthal, and a reply was written on behalf of the Commission by Mr. Carroll L. Wilson, its general manager.

QUESTIONS ARE SUBMITTED

The questions submitted by Dr. Bok and Mr. Wilson's reply follow.

(1) What are the restrictions on free publication imposed on authors of scientific papers in the field of fundamental (as opposed to applied) nuclear research? Are the security regulations similar for the A.E.C. Laboratories (such as Clinton and Brookhaven), for university or industrial laboratories operating in whole or in part under A.E.C. contract and for independent laboratories?

(2) To what extent are scientists in the above classes of laboratories permitted to discuss their work freely with their colleagues in and outside their institutions?

(3) What are the established rules with respect to visitors to the various types of research laboratories referred to above?

(4) What are the established policies with regard to the declassification of research papers in the field of nuclear physics prepared under wartime secrecy regulations?

Dr. Bart J. Bok,
Harvard Observatory
Cambridge 38, Massachusetts
Dear Dr. Bok:

Your letter requesting a statement on information policies of the Commission was forwarded to us by Dr. Bronk.

In general, the Commission's policies in this field are determined by the Atomic Energy Act of 1946, which, in Section 10, instructs the Commission "to control the dissemination of restricted data in such a manner as to assure the common defense and security." In this Section of the Act, Congress quite clearly recognized the importance to the security of the United States, in the broad meaning of that term, of the "free interchange of ideas and criticisms which is essential to scientific progress."

The Commission is currently reexamining many phases of its declassification program and studying a program of dissemination of information which will be consistent with the Act, and with the responsibilities of this Commission in the development of atomic energy. Since the Commission took over the facilities and operations of the Manhattan District on January 1, 1947, the information program has followed the policies inaugurated by the War Department.

It is therefore not possible to give detailed and final answers to your questions, but attached you will find a statement which defines in general terms the policies of the United States Atomic Energy Commission and outlines the current program. I hope this brief statement will be of assistance to you.

Sincerely,
Carroll L. Wilson
General Manager

BASIC POLICY STATED BY THE TOLMAN COMMITTEE

The basic policies of the United States with respect to the release of scientific and technical data developed in the United States atomic energy program were outlined in the "Statement of Recommendations on Release of Atomic Project Information," issued February 4, 1946, by the Advisory Committee on Declassification.

Appointed in the fall of 1945 by Major General L. R. Groves, Commanding General of the Manhattan Engineer District, War Department atomic development agency, this Committee was headed by Dr. Richard C. Tolman, Dean of the Graduate School of the California Institute of Technology. Dr. Tolman was formerly Vice Chairman of the National Defense Research Committee and served as Scientific Advisor to General Groves.

Other members of the Committee were: Dr. Robert F. Bacher, Dr. Arthur H. Compton, Dr. E. O. Lawrence, Dr. J. R. Oppenheimer, Dr. F. H. Spedding, and Dr. H. C. Urey.

In the statement published after the submission of recommendations to General Groves, the Tolman Committee said:

"The directive which this committee was requested to fulfill is to make recommendations as to the release of

information in the interest of national welfare and of national security. In considering the problem we have not intended to minimize the supreme importance of the establishment of international controls, nor are we unaware of the fact that such controls, once established, would profoundly alter the requirements of national security.

We have, however, thought that it would be useful to make all possible progress in releasing valuable scientific and technical information even at the present time when the elaboration of international controls is in its earliest stages. Our fundamental belief is that the release of basic scientific and technical information obtained during the development of the bomb would, over a sufficiently long term, not only enhance our national welfare but actually conduce to our national safety; however, we recognize that those charged with the security of the country may be led to the conclusion that the time is inopportune for the release of certain information of a special nature.

Even so we believe that nearly everyone will agree that there is much that can be disclosed at the present time without danger to our military security. We are convinced that practicable and sound principles can be formulated which will make it appropriate to release such information at once provided the release is carried out with circumspection and discernment under competent and informed guidance. The needless withholding of new developments is bound to delay progress in technical fields, and hence to have serious consequences for our national welfare and security, while the disclosure of a great store of new and useful information will stimulate the growth and development of science and industry. It is to this end that we have primarily directed our recommendations."

DECLASSIFICATION GUIDE SET UP

On the basis of the recommendations submitted by the Tolman Committee, General Groves established a procedure for the declassification of scientific and technical information. A "Declassification Guide" was prepared to delineate the specific topics which the Tolman Committee recommended might be released at once. This Guide, which is classified, is under continuing review and revision in order to insure that information not essential to the security of the United States is made available and that other information is properly safeguarded.

The Atomic Energy Act of 1946, which was signed by the President on August 1, 1946, placed into law the responsibilities of the operating agency —now the United States Atomic Energy Commission—with respect to the safeguarding of "restricted data" as defined in the Act and with respect to the dissemination of information necessary to insure scientific progress.

PROVISIONS OF ATOMIC ENERGY ACT

In its *Declaration of Policy* (Sec.1) the Act states, "It is hereby declared to be the policy of the people of the United States that, subject at all times to the paramount objective of security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace."

The Act further states the purposes of the atomic energy legislation include [sec. 1(b)]:

"(1) A program of assisting and fostering private research and development to encourage maximum scientific progress.

"(2) A program for the control of scientific and technical information to encourage scientific progress, and for the sharing on a reciprocal basis of information concerning the practical industrial application of atomic energy as soon as effective and enforceable safeguards against its use for destructive purposes can be devised."

Section 10 of the Atomic Energy Act of 1946—and it should be kept in mind that this law was more than a year in developing—is devoted to the control of information. This section of the Act states:

"(a) It shall be the policy of the Commission to control the dissemination of restricted data in such a manner as to assure the common defense and security. Consistent with such a policy, the Commission shall be guided by the following principles:

"(1) That until Congress declares by joint resolution that effective and enforceable international safeguards against the use of atomic energy for destructive purposes have been established, there shall be no exchange of information with other nations with respect to the use of atomic energy for industrial purposes and

"(2) That the dissemination of scientific and technical information relating to atomic energy should be permitted and encouraged so as to provide that free interchange of ideas and criticisms which is essential to scientific progress."

In this same section, the Act defines violations and establishes penalties. Section 10 also limits the persons having access to restricted data to those persons who have been investigated by the United States Federal Bureau of Investigation as to their "character, associations, and loyalty."

The term "restricted data" as used in this section is defined as "all data concerning the manufacture or utilization of atomic weapons, the production of fissionable material, or the use of fissionable material in the production of power, but shall not include any data which the Commission from time to time determines may be published without adversely affecting the common defense and security."

INTENT OF CONGRESS GUIDES THE COMMISSION

The intentions of the Congress with respect to information policies appear quite clear. The Congress, in both Section I and Section 10, recognized the importance of "information to encourage scientific progress", but at the same time took into account the situation existing in the world today by establishing a policy of control of information based on the principle that the withholding of certain types of information by the United States would serve to retard specific development of atomic energy for destructive purposes.

It is this principle which guides the Commission in carrying out the program for the control and dissemination of information.

The Commission believes that the basic resources of the United States in entering the intensive program for the development of atomic energy during the war were this nation's tradition of education and aggressive industry.

It further believes that freedom of the "interchange of ideas and criticisms" is the foundation of educational and industrial progress as well as being "essential to scientific progress."

RESPONSIBILITIES OF COMMISSION

The United States Atomic Energy Commission thus has a dual responsibility:

First, to withhold that information whose premature disclosure would aid in the development of, or shorten the time of development of atomic energy for destructive purposes by any nation which is not willing to pool its development effort with other nations in order to provide—in the words of Mr. Baruch—"the mechanism to assure that atomic energy is used for peaceful purposes and preclude its use in war."

Second, to aggressively disseminate that information which is necessary to the understanding by our people of the portent of atomic energy, that information which is vital to the training of the men and women on whom we must depend if we are to realize the promise of atomic energy, and that information which is essential to the development of a strong and virile atomic industry in the wake of an inspired science.

At no point and at no time are these responsibilities separable. Their application requires that restriction be placed upon the free publication of scientific papers, in the fields of both applied and fundamental research. It appears from the program of declassification that the restriction upon publication of fundamental research permits a proportionately greater dissemination of basic science. The restrictions apply wherever scientific research is performed as a part of the United States atomic energy program, both in facilities owned by the government and in contractors' facilities.

Scientists in this program are encouraged to prepare adequate reports of their work and to publish their observations and conclusions as widely as possible. Prior to publication, however, their papers must be "declassified", that is, measured against a Declassification Guide which defines the areas of information which can be released at this time without prejudice to the security of the United States according to the basic standards established by the Tolman Committee and the Manhattan District.

During the first year of operation of this Declassification Program, more than 1200 scientific papers were cleared and authorized for publication. In each case, the author determines the manner of publication, either through his own lectures, through scientific journals, through the general press, or in book form. Those papers which are not published in a medium of general circulation are made available to the public, to scientific and educational institutions, and to industry through the Office of Technical Services of the United States Department of Commerce.

The declassification program is administered by scientific personnel entirely. The application of the established standards, or the Guide, to the information contained in scientific papers, is done entirely by scientists in accordance with principles approved by the Commission on the basis of recommendations by the committee headed by Dr. Tolman.

August 27, 1947

COMMENT OF BOK, FRIEDMAN AND WEISSKOPF

The statement forwarded by Mr. Wilson deals at length with the subject of declassification of papers dealing with scientific work done under the auspices of the United States Atomic Energy Commission. Many scientists outside the United States may not realize how far declassification has progressed.

Exhaustive lists of declassified titles have been published in the BULLETTIN Vol. 2, Nos. 11 and 12 and Vol. 3, No. 1. Further bibliographic material relating to atomic energy has appeared in the same journal (see Vol. 3, Nos. 4 and 5). The Office of Technical Services of the United States Department of Commerce has published for some time a weekly bibliography of scientific and industrial reports dealing with wartime achievements in science in the United States and abroad. Special index volumes are being published by the Department.

SCOPE OF MATERIAL NOW DECLASSIFIED

The total volume of declassified material is gratifyingly large, especially if one keeps in mind that at the close of the war many scientists were reluctant to have appear in print their reports of investigations that were done hurriedly and under pressure, and which, to many of them, seemed uninteresting.

There are papers in a wide variety of fields, including various aspects of nuclear physics, chemistry, biology, medicine, chain reactions, electronics and engineering. There is such a large volume of material that the established scientific journals could hardly have taken care of all of it under peacetime conditions. Indeed the material declassified contains many reports which have not been published and which probably will not be published. Their titles are available in the lists mentioned before, and the reports can be obtained from the Office of Technical Services.

The established scientific journals, for their part, are publishing many of the most important articles, both those reporting on wartime research and those dealing with current research carried on under the auspices of the Atomic Energy Commission. We quote two examples:

1) The *Review of Modern Physics* is about to publish a survey of nuclear cross section data obtained during the war.

2) The *Journal of the American Chemical Society* has recently carried a survey of fission products data ("Nuclei Formed in Fission, Decay Characteristics, Fission Yields and Chain Reactions", J.A.C.S. *68*, 2411 2422, 1946 by Dr. Charles D. Coryell).

As was customary in the years before the war, all papers reporting on research done currently at universities and other laboratories, without an A.E.C. contract, are submitted directly by the author or the head of the laboratory to the editorial staff of the journals. Although the A.E.C. has jurisdiction over all matters related to atomic energy, this procedure applies at present to work done on basic nuclear physics and chemistry.

Scientific papers, not prepared under the auspices of the A.E.C. are submitted to the Commission for checking only when the author or editor feels that a question of security may be involved.

At the present time the United States Army and Navy support extensive research programs, many of them in basic research, in university and industrial laboratories. Some of the support is in the field of nuclear physics. Unofficial estimates (see for example an article by Louis N. Ridenour in the BULLETIN OF THE ATOMIC SCIENTISTS Vol. 3, No. 8) place the total expenditure at ninety million dollars for 1946.

It should be pointed out that the research so supported is *not* military research. American scientists have scrutinized these contracts carefully for undesirable features, and, on several occasions, they have succeeded in eliminating possible restrictive clauses, or undesirable obligations. Maximum freedom of publication is guaranteed under the great majority of these contracts.

OFFICIAL ATTITUDE AND PROGRAM

The official attitude toward the problem of security is illustrated by the following quotation from an article prepared by Dr. Alan T. Waterman, Chief Scientist of the Office of Naval Research and Captain Robert D. Conrad of the U. S. Navy, Director of the Planning Division of the Office of Naval Research (see BULLETIN, Vol. 3, No. 8).

"The secrecy aspect is particularly vexing, since true scientific research is incompatible with any restrictions on the free flow of information. The arrangements we have found workable are as follows: The contractor is entirely free to publish the results of his work, but in his publications not to speculate upon its possible applications in naval or military developments.

"We expect that the scientists who are engaged on projects under naval sponsorship are as alert and as conscientious as we are to recognize the implications of their achievements, and that they are fully competent to guard the national interest. If a development emerges which should be classified, the contractor is given the option of proceeding with it under security restrictions, or having it removed from the campus to a government laboratory or to some other contractor. No one is asked to work in secret against his will."

The official statement by the Atomic Energy Commission, reproduced above, deals specifically with the implications of the Section in the Atomic Energy Act dealing with security. There is, however, another important way in which the Commission influences the practical freedom and direction of science. The Commission covers so wide a field of research, basic and applied, that its own program does in fact represent the decision as to the lines of research to be followed in the near future. A narrowly directed program enforced for the whole field of nuclear research would be equivalent to a stringent restriction on the freedom of scientific research.

Fortunately there is no evidence that the A.E.C. supports such a narrow program. On the contrary at least one Commissioner, Sumner Pike, has spoken strongly for unprogrammatic research, and more than one of the Commission's contracting laboratories, Brookhaven and Berkeley for example, are oriented toward general scientific discovery in nuclear physics and its applications, and not toward secret research. The construction of several accelerators in the one-billion volt region has been started by the A.E.C., chiefly for purposes of basic research on the theory of elementary particles.

REGULATION HAS ITS DRAWBACKS

In spite of the success of the declassification program, and in spite of the sensible approach of the A.E.C. towards the research program, there are necessarily some unpleasant aspects in the regulation of the field of atomic energy.

The control of information and research involves a cumbersome bureaucratic mechanism. With the broadest program and the greatest effort to speed declassification, the A.E.C. can hardly eliminate the inconvenience and time lag at present apparent in the interchange of information between A.E.C. scientists and the world. Even within the A.E.C. information is channelized prior to the formal act of declassification, and the speed with which new ideas and new techniques spread is thus reduced still further. An artificial barrier is created between science inside and outside the A.E.C.

The traditional freedom of discussion of scientific work has necessarily been curtailed. This applies to some extent even after the results of research have been declassified. Declassification of a scientific paper implies approval of a certain set of statements. It cannot foresee the questions that may arise in free discussion and the members of the A.E.C. laboratories can therefore have no assurance about the extent to which they are able to participate in a scientific discussion.

LIMITATIONS ON FREE DISCUSSION

Every A.E.C. scientist cannot become a walking encyclopedia of declassification and, at the moment that he needs to know most, the scientist may not be able to recollect whether or not he is permitted to participate in a certain phase of scientific discussion. Furthermore, a discussion may bring up points on which the formal procedure of declassification has not even been requested.

The inconvenience involved in declassification and the difficulty of participation in free discussions create further artificial barriers. It may well be that a technique of general value for research in university or industrial laboratories may remain unknown unnecessarily long to research workers outside the A.E.C. The danger that a technique shall be accidentally suppressed is only a particular example of the way in which beneficial cross fertilization in science is decreased.

Mr. Wilson points out in his letter to Bok that so far "the information program has followed the policies inaugurated by the War Department". It is somewhat disappointing that the Commission has not yet had the time to clarify or change these policies. Inaction by itself becomes a block to communication. If, for example, the Commission were to determine that publication in certain fields would not adversely affect the common defense and security, then more important investigations would be carried out in

(Continued on Page 344)

CANADA'S PARTICIPATION IN ATOMIC ENERGY DEVELOPMENT

George C. Laurence

This story of the vital contribution of Canadian scientists to the wartime development of atomic energy is told by one of the men who played a leading role at Montreal and Chalk River. Dr. Laurence has been associated with the National Research Council of Canada since 1930, and is currently in charge of one of the divisions of experimentation at Chalk River.

Late on the night of the third of September, 1939, the radio brought to thousands of Canadian listeners, still awake to hear the latest bulletins, the news that the Cunard liner "Athenia" had been torpedoed by a German submarine with great loss of life. This disaster, following in a few hours the broadcast by the Prime Minister declaring an apprehended state of hostilities, brought the realization that Canada was at war.

The weeks that followed were a period of impatience for Canadian scientists. They were told to continue their normal duties until it became clear how their services might be used most effectively. Gradually, however, as Canadian industry turned to the manufacture of almost every kind of equipment of war the technical problems appeared. In six months the need for scientific and engineering personnel was acute. The Wartime Bureau of Technical Personnel was established to control the allocation of their services. As the war went on they were immersed in the development of range finding equipment, anti-aircraft predictors, radar, new and powerful explosives, harbor protection devices, degaussing for the protection of ships from magnetic mines, submarine detection, armor penetrating projectiles, and technical problems in the manufacture of tanks, destroyers, anti-aircraft guns and countless other kinds of military equipment.

In the autumn of 1939, atomic physics seemed frivolous in a nation embarking on war and badly prepared for it. There had been a flush of interest earlier in the year in the thought of atomic power suggested by the discovery of nuclear fission, but it was put out of mind by the urgent tasks of military preparation.

ROLE OF CANADA IN ATOMIC RESEARCH

Meanwhile the scientific periodicals from other countries continued to have articles on nuclear fission. In the United States Prof. A. C. Neir, in May 1940, showed that it was the U235 atoms that underwent fission and released a tiny quantity of atomic energy when exposed to slow neutrons, and not the U238 atoms with which they occur mixed together in natural uranium, thereby confirming the theoretical prediction made shortly before by Neils Bohr and J. A. Wheeler. This suggested the possibility of a new and tremendously powerful military explosive—if only means could be found to separate on a large scale the fissionable U235 atoms from the inert U238 atoms. Now Canada and the Belgian Congo were the two major producers of uranium. Could the possibilities of such a weapon, made from materials that were produced almost exclusively from the natural resources of the Allies, be overlooked?

The difficulties of separating U235 from natural uranium seemed almost insuperable, and certainly beyond Canada's industrial resources. But interest had been aroused, and there was still a hope that even natural uranium, in spite of its content of inert atoms besides the U235, might be made to explode violently if means could be found to reduce the quenching effect of the inert U238 atoms.

The quenching effect is due to the absorption of neutrons by the U238 atoms, for an explosion is only possible if the neutrons thrown out by the bursting of U235 atoms reach other U235 atoms causing them to burst in turn, so that the distintegration spreads from atom to atom until the whole mass flies apart violently. (This propagation of the effect from atom to atom in a continuous chain of bursts is what is meant by a nuclear "chain reaction".)

In Paris, shortly before the war, Prof. Joliot and his associates had reduced the quenching effect of U238 by mixing the natural uranium with water. The water slowed down the neutrons quickly to slow speeds at which the absorption by U238 was relatively less important. But their experiments showed that it would not be possible to produce an explosion with natural uranium and water, because the water itself absorbed too many neutrons.

This led naturally to the question whether some other substance less absorbent for neutrons than water might be used to slow down the neutrons. Rough calculation based on the scanty data available at that time indicated that carbon was the most promising common material. In March, 1940, experiments were undertaken with uranium and carbon in the laboratories of the National Research Council at Ottawa. By September, a bin was erected, lined with paraffin wax, and filled with ten tons of quite pure calcined petroleum coke (a form of carbon used in the manufacture of graphite) in which were embedded uniformly spaced packages of uranium oxide. Curious colleagues were told that the bin contained surplus materials from a nearby laboratory. There was no anxiety about an explosion because it was known that, even if the choice and arrangement of the materials was suitable, the bulk which was used was far below the critical size necessary for a great release of atomic energy. The purpose of the experiments was to

determine, by measuring the behavior of neutrons in this small quantity of material, whether a great release of atomic energy could be produced in a large quantity of the materials, and if so what was the minimum quantity necessary for the purpose.

Meanwhile, Prof. R. H. Fowler arrived in Ottawa in late July, 1940. He had just been in the United States as a member of the Tizard Mission sent out from the United Kingdom to enlist American collaboration in radar development and other war research. Fowler reported that experiments with uranium and carbon, similar in purpose to the work in Ottawa, although somewhat different in methods, were already well advanced in the United States. He said that similar experiments with uranium and heavy water were being undertaken in Cambridge, England. A visit to Dr. L. J. Briggs at the Bureau of Standards in Washington and to Prof. Peagram's laboratory in Columbia led to an exchange of technical information related to the Ottawa experiments during the following year before the United States entered the war.

JOINT PROJECT BY BRITAIN AND CANADA

The experiments continued in Ottawa but the progress made there was far outdistanced in the United States. Under Prof. Fermi's leadership, American scientists had investigated many grades of materials and many arrangements of them, and in Chicago on December 2, 1942, they reached the goal of a working chain reaction. But while the early work in Canada brought only a duplication of prior results in the United States in evaluating that important quantity, the average number of neutrons released for each neutron absorbed in uranium, it served as a preparation for later work in Montreal.

In 1942 the Government of the United Kingdom inquired informally if Canada would be willing to provide facilities for a joint United Kingdom-Canadian atomic energy research project in Canada. The Canadian Government agreed to this proposal and it was decided in September that a laboratory should be established in Montreal under the administration of the National Research Council of Canada with H. H. Halban as Director.

It was proposed that the research work in Canada should be directed towards the development of methods for the production of plutonium, in an atomic energy reactor containing natural uranium. As is now common knowledge, plutonium is, like uranium 235, a fissionable substance which can be used in atomic bombs. The importance of this plan lay in the fact that the extraction of the plutonium produced by this method would be much less difficult than separating uranium 235 from natural uranium. The idea had been considered in the United Kingdom for some time and had been mentioned by Professor Fowler during a visit to the United States as early as January 1941.

It was also planned that the Montreal project should develop an atomic energy reactor in which heavy water, instead of carbon, would be used in association with natural uranium. It seemed probable that it would be much easier to achieve the conditions necessary for an atomic energy chain reaction by using heavy water as the material for slowing down the neutrons. Heavy water, however, has the disadvantage of being very expensive to produce.

The vanguard of the British scientific team arrived in January 1943, and Canadian scientists were recruited into the project. The combined staff grew during the year to about 340. Unfortunately very few of the senior scientists in the United Kingdom who had experience in atomic physics could be spared from urgent work in England on radar and anti-aircraft defence to come to Canada during the first year of the joint project. Nevertheless a group of outstanding scientists assembled together in an old residence as temporary quarters in downtown Montreal, so crowded that bathrooms were used for offices, and books and papers were stacked in the bathtubs.

In February 1943, the staff moved into laboratories in the huge new University of Montreal building on the side of Mount Royal. The heavy water that had been perilously saved from France on the eve of the German invasion was brought out from England—a few hundred pounds which was the world's supply at that time. Equipment was collected and a promising programme of research was planned.

Months of disappointment and discouragement followed for the scientists in Montreal. The problem was how the talent in Montreal might be employed, and the work of the Montreal laboratory coordinated, in a joint American-British-Canadian effort directed towards the development of an atomic bomb. In all other phases of war research there existed the fullest and most profitable cooperation and exchange of ideas between the United States and Canada with its three years longer war experience behind it. This was a different situation. Research in the United States was fully organized and well advanced. There appeared to be no serious problems standing in the way of successful production of plutonium in uranium-carbon atomic energy reactors that could not be overcome by the scientists and engineers in the United States. Moreover, the separation of uranium 235 from natural uranium offered the possibility of another explosive material as a second string to their bow.

DIFFICULT PERIOD OF UNCERTAINTY

The plan of research for the Montreal laboratory was a third method of approach for production of an atomic weapon. It would not assist directly in the two other approaches undertaken in the United States, although it might contribute helpful basic scientific information. There was a feeling in the United States also that close cooperation between the scientists in that country and those in Montreal would involve risks in the wider distribution of secret information possessed by the United States. From the point of view of the Montreal laboratory, information from the United States scientists would save some duplication of research, but of greater importance to the Montreal Laboratory was its dependence at that time on the United States for the manufacture of heavy water and the reduction of Canadian uranium to the form of metal.

During this period of uncertainty, research in Montreal continued to yield data required for the design of a uranium-heavy water atomic energy reactor, but the objectives of the laboratory, its plans and hopes, vacillated with every discussion on collaboration with the United States authorities.

When President Roosevelt, Prime Minister Churchill and Prime Minister Mackenzie King met at the Quebec

Conference in August 1943, it was agreed that the work on atomic energy would progress more rapidly and effectively if all the available effort was concentrated in North America. A Technical Committee consisting of Sir James Chadwick, General Groves, and Dr. C. J. Mackenzie representing Canada, was formed to coordinate the work in Canada in a joint American-British-Canadian programme, carrying out policy decisions made by representatives of the three governments.

COORDINATION OF RESEARCH WITH U. S.

Following this agreement, discussions took place between senior scientists of the Montreal laboratory and the Metallurgical Laboratory of Chicago between the 8th and 13th of January, 1944, and a joint programme of research was planned for the two laboratories in preparation for the first working pilot atomic energy reactor using heavy water, the location of which was still to be decided by the appropriate authorities.

A few weeks later it was agreed by representatives of the three governments that the uranium-heavy water pilot plant should be built in Canada. The Canadian government was to finance the undertaking through the Department of Munitions and Supply. Research and basic design was to be the responsibility of the Montreal Laboratory of the National Research Council of Canada, while the detail engineering design and supervision of construction was to be undertaken by the government company, Defence Industries Limited. Contract for construction of the plant, laboratories and housing was let to the Montreal firm of Fraser-Brace Limited. Dr. J. D. Cockcroft was appointed Director in charge of the atomic energy research in Canada and the staff was increased by additional United Kingdom and Canadian scientists.

Choice of a suitable site for the proposed plant was a difficult question to decide. Access to good river or lake water for cooling the reactor, and proximity to electric power for the operation of the plant's auxiliary equipment, were important considerations. It was thought necessary to locate it in a thinly populated area, for at that time there was less knowledge of the risks of explosion, but it was desirable that it should be within easy reach of industrial centers and scientific communities. Finally a location was chosen on the south bank of the Ottawa River, near Chalk River and 130 miles west of Ottawa. Ten thousand acres were expropriated to contain the plant, laboratories and the town for habitation of the employees, and to give security and isolation from nearby population.

The town was laid out a few miles from the Chalk River plant on the location of an old log cabin Indian settlement, among the pines, birches and poplars above a sand beach facing the Laurentian Hills of Quebec across the river. It was called Deep River, the English translation of the name given to this part of the Ottawa River three centuries ago by Champlain and his companions, who, working their way upstream in birch bark canoes, were the first white men to explore the region.

Gradually, as laboratories were built at Chalk River, part of the research staff moved there from Montreal. On the fifth of September, 1945, Lew Kowarski, telephoning from Chalk River, informed his colleagues in Montreal that the "ZEEP", the first atomic energy reactor in Canada, was put in operation that morning. The ZEEP got its name from the initials of the words "zero energy experimental pile", a recognition by slight understatement that this "pile" (as a reactor is sometimes called) could be operated to yield only very low energy. It was designed to provide means for testing details in the design of the pilot atomic energy plant which was being built. Later, the ZEEP was very useful for research in atomic physics.

As the pilot plant, laboratories and town neared completion, their administration and management were taken over entirely by the National Research Council of Canada, under the direction of Dr. David Keys. W. B. Lewis was appointed Director of Research, succeeding Cockcroft, who returned to England to take charge of atomic energy research at Harwell. Meanwhile the Montreal Laboratory was vacated in June, 1946.

While the research programme in the Montreal Laboratory was chiefly concerned with obtaining scientific information and data required for the design of the Chalk River pilot plant, it led to some advances in fundamental nuclear science. One example of this was the tracing out of a new series of radioactive elements similar to the three well known series in which radium, thorium and actinium occur, thereby filling a long suspected gap in the list of radioactive substances. It happened in this way. During 1943 P. Demers devised remarkable photographic plates which were particularly suitable for studying the small atomic fragments called alpha-particles which are thrown out of radium and some other radioactive atoms. The passage of the particles through the sensitive emulsion on the plates is recorded by a line of tiny black dots that can be seen with the microscope. Demers dissolved in the emulsion uranium 233, a substance which is produced from thorium by exposing it to neutrons. He found that the lines of dots produced by alpha particles occurred in groups radiating from a center like the spokes of a wheel. The fact that several lines radiated from the center meant that the uranium 233 atom changed into a sequence or series of several other kinds of atoms that emit alpha particles. He, and some of his colleagues using other experimental methods, then succeeded in identifying the members of the series as new radioactive substances and in determining some of their properties.

SAFEGUARDING OF INFORMATION

An important feature of Canadian activities in the field of atomic energy has been the safeguarding of security and secrecy throughout the laboratories, the plant, refineries and the mines. There are the armed guards and there is the control of documents, but behind it all there is the efficient, constant vigilance of the Royal Canadian Mounted Police, in repeated checking of the background and associations of the staff and of all those with whom it is necessary to deal for the supply and handling of critical materials, and in countless other ways. Security is facilitated in Canada by a number of factors; the density of population is low, the number of foreign born immigrants (except from the United States) is comparatively small, and there are no large ethnic groups or communities in eastern Canada retaining strong alien sympathies.

Technical discussion on atomic energy between Canada and the United

States has been restricted exclusively, since American entry into the war, to basic physics. Yet it reduced the research that had to be done independently in Canada by saving months of duplication of work. Canada has not received from the United States any engineering information or "know how", nor any information related to the production of atomic bombs, such as information on the separation of Uranium 235, nor methods for the extraction of plutonium, nor the design and manufacture of the bomb itself. The engineering design of the Chalk River plant, the development of the methods used there for the extraction of plutonium and other products, was done in Canada entirely independently. Full information, however, has been made available to the United States on all research and development in atomic energy in Canada.

CANADA'S RELATION TO CURRENT DEVELOPMENTS

The activities at Chalk River are directed toward basic research and the peaceful applications of atomic energy.

Canada's contribution to the Atomic bomb was in the extraction of the uranium compounds from the uranium ore and in supplying uranium from its mines. This contribution might not have been possible were it not for the initiative and energy of one man. In the middle of May, 1930, Gilbert Labine, accompanied by E. C. St. Paul, prospecting on the shores of Great Bear Lake, discovered showings of uranium. Chiefly as a result of Labine's imagination and enterprise, mining operations were started, and mills were constructed at Great Bear Lake, and a refinery for the extraction of ore was built at Port Hope, and by May 1933 the first gram of radium was extracted from Canadian uranium. The mines, the mills and the refineries were ready when the time came to supply uranium for the manufacture of atomic bombs.

Canada, with its natural resources of uranium, and its occupation in research and development in the field of atomic energy, is deeply aware of the dreadful possibilities of atomic warfare. The Washington Declaration on December 15, 1945, signed by President Truman, Prime Minister Attlee and Prime Minister Mackenzie King, led to the establishment of the United Nations Atomic Energy Commission, on which Canada is represented by General A. G. L. MacNaughton, charged with the responsibility of formulating plans for the international control of atomic energy. The Government of Canada, anticipating the establishment of an international system of control of atomic energy requiring the collaboration of the nations of the world, took steps to ensure that Canada would be in a position to participate effectively in such an international system to the extent that might be necessary to give security from atomic war. The Atomic Energy Control Board was established on August 31, 1946, with wide powers to control all activities associated with the release and use of nuclear energy in Canada. The Atomic Energy Control Board has powers to control the operation of the uranium mines at Great Bear Lake and the refineries at Port Hope, which had already been purchased by the government from private ownership three years earlier. The Atomic Energy Project at Chalk River also came under the control of the Atomic Energy Control Board, being administered on its behalf by the National Research Council of Canada. The Atomic Energy Control Board has the responsibility also of fostering atomic energy research. This it does not only by financing the Chalk River project, but by assisting universities by grants for equipment for research in the field of atomic energy.

The production of atomic weapons is beyond Canada's industrial resources. Canada's Atomic Energy Project is directing its efforts towards the extension of basic scientific knowledge, the training of young scientists, and the development of the applications of atomic energy for peaceful purposes and for the benefit of mankind.

LETTER TO THE EDITORS

Dear Sirs:

In the September issue of the BULLETIN OF THE ATOMIC SCIENTISTS there appeared in a slightly condensed form the six papers on Functions and Powers of the International Atomic Energy Control Agency which constitute the recently prepared Second Report of the Atomic Energy Commission to the Security Council.

Although the texts of the reproduced material are entirely correct, the brief explanatory notes preceding each text are rather misleading, and give a completely wrong inpression of the procedure actually used in their preparation. In fact, on the basis of the information given in the BULLETIN one can reach but one conclusion, that is, that the submitted papers have always represented the consensus of opinion of all members of the working group appointed to prepare the respective documents.

Actually, the situation was quite different. As a member of two of the working groups I would like to make it quite clear that the corresponding papers "on the Agency's research and development activities", as well as "the Agency's rights and limitations relating to inspections, surveys and explorations" have not been unanimously agreed upon, and in their final form do not reflect my point of view with regard to many of the discussed questions. The fact is that according to the adopted procedure my alternative proposals or reservations appeared only in the original drafts of the above mentioned documents and have been dropped in their revision by the Sub-Committee of Group Leaders. Therefore, the papers in their final form by no means represent the views of all the members who participated in the preparatory work (and whose names are given in the BULLETIN as those of the authors of the individual documents) but only the position taken by the majority . . .

Very sincerely yours,

IGNACY ZLOTOWSKI

Representative of Poland
on the Atomic Energy Commission

The editors respectfully call Mr. Zlotowski's attention to page 253 of the September issue which specifically states: "Those who prepared these papers acted as individuals. Neither governments nor even individuals are at this stage committed to the proposals presented."

UNITED NATIONS ATOMIC ENERGY NEWS

Peter Kihss

The BULLETIN offers this first-hand report of events at Lake Success as a regular monthly feature. Mr. Kihss, a staff member of the NEW YORK HERALD TRIBUNE, has specialized in Atomic Energy Commission activities.

Continued refusal of the minority to join with the majority may "soon" confront the United Nations Atomic Energy Commission with the conclusion that it cannot accomplish its job of working out international controls, according to a warning voiced by Secretary of State George C. Marshall in the General Assembly.

The Soviet Union retorted, through Deputy Foreign Minister Andrei Y. Vishinsky, that it was American and British activities which cause alarm over the task.

With most delegates enmeshed in work of the Assembly which convened September 16, the atomic commission itself took a recess after adopting its second report to the Security Council September 11.

MR. ARANHA OPENS THE ASSEMBLY

Opening the Assembly, *Oswaldo Aranha, of Brazil,* said it was "not enough to ban the use of weapons such as gas, atomic bombs and means of mass destruction." He said the task was "to impart to all peoples and to all men in all regions a thorough confidence in our organization. Only thus can we disarm them for war and equip them for cordiality and for peace."

That night, *Warren R. Austin, chief American delegate* to the Security Council and Atomic Energy Commission, in a Colombia Broadcasting System address, said the lack of greater progress in atomic control was "a heavy millstone that slows efforts for the reduction and control of other armaments." He added: "We must ascertain whether there is possible in the near future agreement with the Soviet Union on effective, enforceable safeguards against the use of atomic energy for destructive purposes."

General debate, which opens the work of the Assembly, found thirty-eight nations expressing their views, and of these, seventeen referred to the atomic problem. A digest follows:

U. S. AND POLAND ON DISARMAMENT

Secretary Marshall said control of atomic and other weapons of mass destruction has "perhaps the highest priority if we are to remove the spectre of a war of annihilation." He said the commission majority had made "real progress" in spelling out detailed functions of an international control agency, but the unwillingness of two nations to join the majority conclusions was "a disturbing and ominous fact."

"Failure to agree on a system of control which can provide security against atomic warfare will inevitably retard the development of the peaceful uses of atomic energy for the benefits of the peoples of the world, and will accelerate an atomic armaments race," Secretary Marshall said.

"Since the United States realizes fully the consequences of failure to attain effective international control, we shall continue our efforts in the Atomic Energy Commission to carry forward our work along the lines of the majority views.

"We must state frankly, however, that in the absence of unanimous agreement on the essential functions and powers which the majority has concluded must be given to the international agency, there will necessarily be limitations on the extent to which the remaining aspects of the problem can be worked out in detail.

"If the minority persists in refusing to join with the majority, the Atomic Energy Commission may soon be faced with the conclusion that it is unable to complete the task assigned it under its terms of reference laid down in the General Assembly resolution of 24 January, 1946."

Secretary Marshall favored work on a system of general arms regulation, but said such a system couldn't be put into operation until conditions of international confidence prevail. These conditions would presuppose peace settlements with Germany and Japan, agreements putting military forces and facilities at the disposal of the Security Council and "an international arrangement for the control of atomic energy.

Foreign Minister Zygmunt Modzelewski, of Poland, said it was "not correct to divide on the basis of various kinds of weapons, more or less important, more or less destructive. Either you disarm or you do not disarm. Although we realize that in practice the complete fulfillment of disarmament may, and must, proceed by stages, we still feel that one general principle must serve as a basis, and that is, to cover all categories of weapons, including the atomic weapons."

Senator Jose Maza, of Chile, said the United Nations cannot allow "the peoples to busy themselves developing political and economic situations calculated to provoke another war, especially where the step to military operations is always the shortest in the whole tragic course of any conflict."

COMMENT ON PROGRESS OF A.E.C.

External Affairs Minister Herbert V. Evatt, of Australia, said the two atomic commission reports, if their recommendations were put into effect, "would constitute a landmark in international cooperation." He said their principles and most details had

"now been indorsed by thirteen of the fifteen members and ex-members of the Atomic Energy Commission."

Two advances had been made in the past year, the Australian said. "It is now unanimously agreed that there must be inspection by international personnel of facilities relating to atomic energy, from the mining of raw materials to the final development of power. It is also agreed that there should be no veto on the day-to-day operations of the international control organ."

Carlos Eduardo Stolk, of Venezuela, said the results obtained in the atomic commission were "not satisfactory" and "the subject requires urgent solution. At this time of economic poverty, it is necessary that resources should not be squandered in an armament race, but that they be used as far as possible to meet human needs, so as to achieve true security and effective exercise of freedom." Nations should be freed from the fear of atomic war, he said, and "we request all the great powers to reach an agreement in order to attain an effective implementation of the terms of reference given them by the charter."

Alberto Ulloa, of Peru, said Peru had not been a member of the atomic commission, and added: "But we can express our opinion in favor of the United States' position on this question, which country is ready to abandon its technical advantages, that had such a cruel but decisive influence on the war in the east, in exchange for international control, certain that the advantages thus gained are for the best and would eliminate all kinds of uncertainty for the future."

VISHINSKY DENIES ANY PROGRESS MADE

Andrei Y. Vishinsky, of the Soviet Union, said American-British unwillingness to disarm gives rise to "justified apprehension and alarm with regard to the possibility of successfully completing the undertaken task. The speedup of armaments, atomic weapons included, and military preparations of some militarily and economically powerful states particularly promote the spreading of the feeling of alarm and anxiety."

He said the atomic negotiations were "particularly unsatisfactory," and justified anxiety because "atomic weapons are weapons of attack." None of the atomic commission's tasks has been completed after a year and a half's work, and "there has not been the slightest progress in the fulfillment of those tasks."

BLAMES U. S. FOR FAILURE

Soviet proposals on outlawing atomic weapons and establishing international control had met resistance mainly from the United States, Mr. Vishinsky said. "The United States of America, believing that it will continue to exercise a monopoly with regard to atomic weapons, resists any attempts to dismantle the existing stock of atomic bombs and outlaw their further production." The United States "systematically increases the production of such bombs."

Mr. Vishinsky said disagreement "hinders" the commission work and "paralyzes all efforts." Disagreements could have been eliminated by "a more objective approach." The commission majority "agreed in principle" on destroying the stock of atomic weapons and using their nuclear energy for peaceful aims, Mr. Vishinsky said. "Only one delegation, to wit the delegation of the United States of America, continues to object to the destruction of atomic bombs, thus obstructing a decision on the question approved by the majority of the commission."

The United States was stressing inspection "only a few weeks ago," and the Soviet proposals put inspection second only to outlawing atomic weapons, Mr. Vishinsky said. But the American delegation has "unexpectedly begun to lessen the importance of inspection," and put ahead the international ownership, management and licensing of atomic activities.

The Soviet stands for strict international control over atomic plants, "but such a control, however, which should not be transformed into interference with those branches of national industry and with those questions that are not connected with atomic energy." Rights of inspection should exclude "arbitrary intervention into any branches of national economy," which "can only undermine and destroy the national economy of any country."

"The United States delegation and some other delegations who support it insist particularly that the international control authority, transformed into an owner and acting according to the interests of the majority of this authority, on whose benevolent attitude the Soviet Union cannot count, should own and manage all plants manufacturing atomic materials in a dangerous quantity," Mr. Vishinsky said.

The Soviet opposes and will remain opposed to this thesis, he added, and is "trying to achieve not a dominance of a single nation in the international control body but equality of all participants in this body in all its activities."

"The United States representatives," Mr. Vishinsky said, "propose to postpone indefinitely the establishment of control over the most dangerous final stages of the atomic manufacturing, stages in which the United States considers itself at the present time to be holding a monopoly. At the same time, the United States insists that control over the initial stage, extraction of the raw material, should be immediately introduced.

"It is abundantly clear that the American position cannot be otherwise interpreted but as a position according to which the control is not to be extended to the United States of America while all other countries should come right away under the international control."

NAMES WARMONGERS AND OFFERS RESOLUTION

An attack on war-mongering constituted the main theme of Mr. Vishinsky's speech. In atomic research, he said, "such capitalist monopolies like Dupont Chemical Trust, Monsanto Chemical Company, Westinghouse Company, General Electric, Standard Oil and others are most closely connected with this research work, being complete masters in the field." He blamed monopolies for resisting outlawry of atomic weapons "in the manufacture of which tremendous sums are invested." He charged a number of Americans with advocating atomic attack on Russia.

Mr. Vishinsky ended with a four-point resolution to condemn warmongering, particularly in the United States, Turkey and Greece, with governments urged on pain of criminal

punishment to prohibit war propaganda. The resolution would end with a reaffirmation of the need of effecting earlier Assembly disarmament and atomic control resolutions as soon as possible, since "the implementation of these decisions meets the interests of all the peace-loving nations and would be the heaviest blow upon the propaganda and the instigators of a new war."

Jose Arce, of Argentina, blamed lack of Security Council formulation of treaties to regulate armaments on the existence of the veto, which authorizes any permanent member to "paralyze the action of the whole body."

SMALL COUNTRIES EXPRESS OPINIONS

Foreign Minister Kuzma V. Kiselev, of Byelorussia, said "the controlling figures in corporations and trusts and syndicates in certain countries are taking all possible measures to wreck the work of the Atomic Energy Commission." He charged American atomic proposals would assure the United States "the decisive role" in atomic development, and "the absence of any kind of peaceful progress is because of the position taken by the United States delegation in the Security Council."

"It must be stated clearly," Mr. Kiselev went on, "that those peoples are direly mistaken who hope that the monopolistic position in connection with the atomic bomb of any one country can be maintained for any length of time. The head of the Soviet Union delegation, Foreign Minister Motolov, at the last session of the General Assembly, stated that science and its standard bearers, the scholars, cannot be taken into a box and they cannot be locked up.

"We should not forget that the atomic bomb of one side may be answered by atomic bombs of the other side, and by something more, and that would be the final crash of all the calculations of certain self-satisfied but not smart people. . . . The Byelorussian delegation is hopeful that this problem will be positively settled by the Security Council in the near future."

Foreign Minister Jan Masaryk, of Czechoslovakia, said: "If the whole world is divided into two definite parts, there is only one way out of it—the same experience my country had from 1938 until 1945, with the important potency of the atomic bomb thrown in for the special benefit of the innocent and the peace-loving." He heartily agreed, he said, with Mr. Vishinsky's proposal that Assembly decisions on disarmament and atomic weapons outlawry "should be put into effect as soon as possible."

J. H. van Roijen, of the Netherlands, said there did not seem to be much reason for optimism with regard to results of the atomic commission's deliberations. "The Netherlands, which was a member of the commission until the end of last year, does not hesitate to associate itself with the conclusions reached by the majority of the members. However, it is to be hoped that the deadlock now existing in that commission between the majority and the minority will finally be broken and a general agreement reached.

COMMENTS BY MR. AUSTIN AND MR. McNEIL

Mr. Austin spoke before the American Association for the United Nations September 20, and said, "the power and authority of the United Nations would be vitalized" by establishment of world police forces, atomic safeguards and disarmament. He said peace was the purpose of all, but methods followed by the Soviet Union are "ill-conceived and have more tendency to generate hate and war than love and peace."

Mr. Austin said "these methods, which led up to Mr. Vishinsky's speech, include obstruction of the will of the majority in the establishment of peace forces by the Security Council, in the Atomic Energy Commission and in the Commission for Conventional Armaments." He said the Soviet Union, although invited, "failed to participate in formulating specific proposals" on functions of an atomic control agency, and had proposed instead a control system which would "accentuate national rivalries."

Hector McNeil, British Minister of State, told the Assembly that atomic and disarmament work had been delayed because "the Soviet representative, who fortunately here has no veto, continued throughout the year to be guided by his own interpretation of the subject, and therefore refused to conform to the plan of work being developed by the overwhelming majority of the commission." Mr. McNeil said the Soviet representative had achieved "a new weapon—the slow veto: He has retarded the work persistently not by voting 'no,' but by a policy of non-cooperation despite a large majority against him."

Mr. McNeil said the United States was ready to prohibit atomic weapons as soon as an effective security system was working in all its particulars, and on the same conditions to accept not only inspection but actual ownership and management by an international agency.

"If my understanding of the United States attitude is confirmed by a study of the appropriate documents, if the United States representative is willing to come to this stand, as I have no doubt he is, to confirm that that is the attitude of the United States administration, then I say it is one of the most remarkable offers recorded in the history of disarmament proposals," Mr. McNeil went on.

"If I am to be disputed, let Mr. Vishinsky come again to this rostrum to tell us of some monopoly of the Soviet Union in armaments which he and his government are willing and anxious to place under international ownership and control. . . .

"It is, I think, desirable that the Assembly should know that although work on this plan has still a long way to go, it must continue to be the object of intensive and detailed study. It is developing along lines which give promise of general security.

"The immediate point is that if the Assembly is disturbed by the slow progress made by these two commissions, although the progress they have made should not be underestimated, it has an obligation to satisfy itself as to the cause of the delay, and I am certain that they must conclude, as I have already indicated, that the blame for delay should be laid upon the shoulders of the Soviet government."

ATOMIC BOMB AN "UNFORTUNATE DISCOVERY"

Faris el Khouri, of Syria, said an atomic war would end civilization. "To intercept this horrible eventuality, the United Nations must accelerate the conclusion of definite conventions to be pledged and ratified by member states, aiming at the prohibition of the use of atomic energy in its production and use."

"This unfortunate discovery of releasing the formidable energy of atoms," the Syrian said, "is now

(Continued on Page 334)

THE SECOND REPORT OF THE UN A.E.C. TO THE SECURITY COUNCIL

The first report of the UN Atomic Energy Commission to the Security Council, transmitted on December 31, 1946, was reprinted in the BULLETIN (Vol. 3, No. 1). We cannot do the same with the Second Report, transmitted on September 11, because it is largely indentical in content with the six "Working Papers" which were reprinted, in condensed form, in the September issue of the BULLETIN. We present therefore only a "skeleton" description of the report, referring to the "Working Papers" for the "meat".

WORK OF COMMISSION REVIEWED

The report was transmitted with a letter to the President of the Security Council by General A. G. L. McNaughton (Canada), at that time chairman of the Commission. We quote from this letter: " . . . In continuing its task, the Commission intends to proceed with the study of the topics noted in the Introduction to the report, . . . with a view to making the specific proposals required by the resolutions of the General Assembly of January 24 and of December 14, 1946 and to preparing, in due course, a draft treaty or convention incorporating its ultimate proposals."

The report opens with a review of the proceedings of the A.E.C. from January 1 to September 11. The Introduction states: ". . . The work has had two principal aspects: discussion of the points of disagreement expressed by the Soviet Union and the formulation of specific proposals by the Commission.

"Twenty-three committee meetings have been devoted to the consideration of the views of the Soviet Union. . . . The discussion on the Soviet Union amendments . . . has not led the Commission to revise the General Findings and Recommendations of the First Report. The discussion on the Soviet Union proposals of June 11, which is summarized in Part IV, has led to the conclusion that "these proposals as they now stand and the explanations given thereon do not provide an adequate basis for the development by the Committee of specific proposals for an effective system of international control of atomic energy." It is evident, therefore, that these discussions have not led to a reconciliation of the views of the Soviet Union with those of the majority of the Commission on major points of principle.

"In accordance with the terms of reference . . . the Commission undertook the drafting of specific proposals . . . which . . . deal with the functions and powers of an international agency for the control of atomic energy, . . . evolved from the considerations advanced in the First Report. They give expression to certain basic principles including:

1 Decisions concerning the production and use of atomic energy should not be left in the hands of nations.

2 Policies concerning the production and use of atomic energy which substantially affect w o r l d security should be governed by principles established in the treaty or convention which the agency would be obligated to carry out.

3 Nations must undertake in the treaty or convention to grant to the agency rights of inspection of any part of their territory, subject to appropriate procedural requirements and limitations.

BASIC MEASURES PROVIDED

"In implementing these principles, the following basic measures are provided:

(a) production quotas based on principles and policies specified in the treaty or convention

(b) ownership by the agency of nuclear fuel and source material;

(c) ownership, management, and operation by the agency of dangerous facilities;

(d) licensing by the agency of non-dangerous facilities to be operated by nations; and

(e) inspection by the agency to prevent or detect clandestine activities.

"The majority of the Commission concludes that the specific proposals of this report . . . taken together with the General Findings and Recommendations of the First Report, provide the essential basis for the establishment of an effective system of control to ensure the use of atomic energy only for peaceful purposes and to protect complying s t a t e s against the hazards of violations and evasions. . . .

AGREEMENT ESSENTIAL ON FUNCTIONS AND POWERS

"In addition to the functions and powers of the international agency, there are other important matters listed for discussion. These are the organization and administration of the agency, geographical location of dangerous activities and stockpiling, financial and budgetary organization, prohibitions and enforcement, and the stages of transition from the present situation to a system of international control. These are subjects which, in the opinion of the majority of the Commission, for the most part, can be discussed effectively only in the framework of conclusions reached with regard to the functions and powers of the international agency. Further work of the Commission on these matters will be based on the specific proposals of this report and on the First Report.

"It is evident that, until unanimous agreement is reached on the functions and powers of the international agency, there will be limitations on the extent to which proposals on other topics in the Summary of Principal Subjects can be worked out in detail. Clearly, much remains to be

done before the final terms of a treaty or convention can be drafted. The Commission intends to proceed with the remaining topics in the summary and, at the same time, will continue its endeavors to clarify and resolve, where possible, the existing points of disagreement."

The history of the proceedings in the Working Committee and the Control Committee, re-told in *Part I*, has been regularly reported in the BULLETIN. The report gives the following list of topics adopted by the Control Committee for consideration on April 10: (These "terms of reference" of the "Working Papers" have not been published before.)

TOPICS CONSIDERED BY CONTROL COMMITTEE

A Subjects required to establish the initial framework of a draft treaty or convention (many of these subjects might be discussed concurrently).

1 Definition of terms to be used in the treaty.

2 Operational and developmental functions of the international agency and its relation to planning, coordination, and direction of atomic activities.

(a) Functions of the international agency in relation to research and development activities.

(b) Functions of the international agency in relation to location and mining of ores.

(c) Functions of the international agency in relation to processing and purification of source material.

(d) Functions of the international agency in relation to stockpiling, production, and distribution of nuclear fuels.

(e) Functions of the international agency in relation to design, construction, and operation of isotope separation plants.

(f) Functions of the international agency in relation to design, construction, and operation of reactors.

(g) Rights of and limitations on the agency and its personnel in respect to inspection, operation, and other control functions.

3 Organization and administration of the international agency.

(a) Organizational structure.

(b) Relations to other organs of the United Nations, to other international agencies, and to individual nations and their national agencies.

(c) Status of the agency and its personnel in its operations within individual nations.

(d) Definition of types of operating decisions subject to review and those not subject to review.

(e) Determination of review body or bodies and of principles governing review.

B Subjects which can only be discussed effectively in the framework of decisions reached on subjects listed in A above.

1 Principles governing geographical location of dangerous activities and stockpiling.

2 Financial and budgetary organization.

(a) Determination of sources of funds and types of expenditures.

(b) Estimates of financial burden to be borne by individual nations.

(c) Principles governing allocation of expenses to individual nations.

(d) Principles governing financing of both facilities owned and facilities not owned by the agency.

3 Prohibitions and enforcement.

(a) Definition of individual and national prohibitions.

(b) Examination of the nature of direct international jurisdiction over individuals and the principles governing the application of individual punishments.

(c) Examination of the problems related to the application of sanctions against nations, including the veto problem.

(i) Method of determining violations.

(ii) Application of economic and other non-military sanctions.

(iii) Application of military sanctions.

4 Examination of the stages by which transition will be accomplished from conditions of national control to the final conditions of predominantly international control."

Comparison of this list with the content of the report shows that the latter covers fully only the parts A1 and A2. The report then lists the working groups assigned to the consideration of various topics on the list, and reveals that in addition to the six groups whose "Working Papers" have been submitted, a seventh was formed for the preparation of a paper on "Organization and Administration of the International Agency" but has not yet submitted their conclusions. It is also revealed that Prof. Skobeltsyn (U.S.S.R.) was asked to take part in the deliberation of this group, as well as of the group dealing with "Processing of Source Materials", but has declined participation.

AMENDED PROPOSALS TO PART II

In *Part II*, the six "Working Papers" are reproduced, with mostly minor amendments and editorial changes. The most essential amendment, proposed by Australia, Canada and the U.S., changes the text of specific proposal III in the paper on "Location and Mining of Ores" (BULLETIN, Vol. 3, No. 9). The amended proposal reads, in condensed form:

(a) REPORTS FROM NATIONS

"Nations shall furnish . . . reports which shall describe the location, amount . . . and mode of occurrence of source material known to be present . . . within their . . . territories. The areas which have been surveyed or explored for source material, as well as any areas in which such surveys or explorations are in progress or are planned, . . . likewise shall be described . . . .

(b) VERIFICATION OF REPORTS

". . . The agency shall conduct inspections, surveys, and explorations to check the information reported . . . In areas which are reported . . . not to contain significant quantities of source material, the agency shall determine the extent to which it should conduct inspections, surveys, or explorations and the methods to be used. Factors to be considered . . . include the geology of the area, . . . the degree of completeness, . . . of the data reported, . . . the accuracy of information reported by the nation and already checked by the agency, and the presence or absence of any other grounds for believing that the area involved contains source material. A nation shall have the right to appeal to an appropriate international body against what it may consider to be an improper use by the international agency of the powers of conducting surveys and explorations in the case of areas reported not to contain source materials . . . .

(c) DISCOVERY OF NEW DEPOSITS

". . . The agency shall conduct or arrange with nations for the conduct of surveys and explorations to discover new deposits of source material. This includes the right . . . to re-survey or re-explore areas which have previously been surveyed or explored either by the agency or by nations . . . A nation shall have the right to appeal . . . against what it may consider to be an improper use . . . of the powers of conducting surveys and explorations in the case of areas reported not to contain source material . . . .

(d) AREAS CONTAINING SOURCE MATERIAL

". . . The agency shall conduct routine inspections and surveys and intensive explorations of areas which are known to contain significant quantities of source material and of all mines in such areas. The routine inspections and surveys will be primarily for the purpose of preventing or detecting clandestine activities in these areas. The extensive explorations will be primarily for the purpose of checking and supplementing existing information as to the location, amount, character, concentration, and mode of occurrence of the source material. The agency shall analyze, coordinate, compile, and publish all data concerning known supplies of source material . . . ."

Comparison with the original text as published in the BULLETIN indicates a better and apparently wider definition of the rights of the Agency to determine for itself what it shall do in inspecting and exploring regions which nations have reported as containing no deposits of source materials.

SOVIET AMENDMENTS STILL CONSIDERED

Part III and IV of the report are devoted to the discussions of the Soviet amendments to the First Report and of the Soviet June 11 set of proposals respectively, matters which, too, were described at the time in the BULLETIN. These discussions were not considered as terminated, but were temporarily concluded on August 15 by the adoption of the Canadian resolution in the Control Committee asserting that the Soviet proposals (together with the answers to the Cadogan questionnaire, BULLETIN, Vol. 3, No. 9., still do not "provide an adequate basis for the development of specific proposals for an effective system of international control". In the debates on this resolution, the Canadian and other delegates stressed that it does not mean a refusal to consider further the Soviet proposals, but merely the intention not to let this consideration interfere with the further elaboration of the plan now on the agenda of the Control Committee.

Annexes to the report contain a calendar of the meeting, a list of representatives, and the summary records of several of the most important sessions (the latter not yet issued). Included are meetings on August 6, 8 and 11 in which other nations took a stand on the Soviet inspection plan.

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(Continued from Page 331)

spreading fright throughout the world and bringing the prospect of misery rather than bliss to millions of mankind. If we are unable to eliminate this dangerous invention by turning it back to the mysteries of nature, we should at least chain it and render it incapable of sinking its fearful talons in the flesh of its prey."

Alfonso Lopez, of Colombia, said the permanent members of the Security Council had not agreed upon measures "either on conventional armaments or atomic energy control, or on the elimination from national armaments of all major weapons adaptable to mass destruction, or on the armed forces to be made available to the Security Council for the purpose of maintaining international peace and security, or on the evacuation of foreign troops stationed on the territories of member states without their consent.

"Months and months of constant and fruitless effort have elapsed without any prospect of a reasonably early agreement between the Soviet Union on the one hand, and China, France, the United Kingdom and the United States of America on the other," Mr. Lopez said. It had been impossible to make a satisfactory start on disarmament because the great powers differed over the priority for various questions.

Foreign Minister Stanoje Simic, of Yugoslavia, asserted the countries of western Europe, including Germany and Austria, are "a paradise for quislings and traitors from Eastern Europe. Such people live and work freely in these countries, and carry on active propaganda for an atomic war against the countries of their origin, not only written and oral propaganda but also over their own radio stations."

Guillermo Belt, of Cuba, said: "The fear of new armaments, and especially the atomic bomb, might be the direct cause of another war. It is, therefore, necessary and indispensable not only to achieve world disarmament, but also to create a world organization with supreme international authority capable of the inspection and control of atomic energy."

Foreign Minister Dmitri Z. Manuilsky, of the Ukraine, said the basic problem which should have engaged United Nations attention was carrying out of the Assembly recommendation on arms reduction and suppression of atomic weapons, supplemented by action against war-mongers. He blamed United States monopoly aims and hopes of using atomic weapons for coercion as the cause of the atomic stalemate, and asserted "without the suppression of this atomic weapon there can be no genuine disarmament."

FEAR AND SUSPICION REAL CAUSE OF DELAY

The general debate was followed by a speech by *Secretary General Trygve Lie,* who told the Assembly that in many political questions, "for example the control of atomic energy, two parties are definitely at odds, even though both of them have the same interest in securing effective control."

"The greatest difficulty," Mr. Lie said, "lies in the fact that the great powers suspect each other or each other's intentions. It is fear which is the greatest danger. Fear breeds hate, and hate breeds danger."

Nations must strive to live and work together, Mr. Lie declared, and "this must find expression in political negotiations which show a willingness to compromise."

ATOMIC ENERGY IS *YOUR* BUSINESS

David E. Lilienthal

Speaking to a community meeting at Crawfordsville, Indiana on September 22, Mr. Lilienthal tells the people of an American community how they may share and control the development of atomic energy. Mr. Lilienthal's remarks are reprinted in full.

There is a growing tendency in some quarters to act as if atomic energy were none of the American public's business.

It isn't said in just those words, of course. It is put more discreetly. It is said that the subject is too "technical" for public discussion—or that "national security" requires that the public be kept in the dark, even on discussions of broad policy—or that the steps that need to be considered are such strong meat that all these matters must be withheld from the public. It is said, in support of this practice, that it was followed successfully in wartime, and hence should be continued today.

In my opinion this is plain nonsense, and dangerous nonsense, dangerous to cherished American institutions and for that reason dangerous to genuine national security. And if I sound belligerent it is because on this issue I am in a fighting mood. I have come back home to Indiana to say so, as emphatically as I can.

I say to you that atomic energy and scientific discoveries have not and need not change the fundamental principles of democracy, which rest upon faith in the ultimate wisdom of the people, when they have been truthfully and clearly informed of the essential facts. This principle and this faith form the basis of the law establishing the civilian Atomic Energy Commission. If the people of this country want that principle and that policy to be made effective—the policy that it is *they* who decide their future and their fate—that is the policy that will prevail.

I propose tonight to suggest a specific program whereby here in Crawfordsville and in all other American communities the people on their own can set about to learn the essential facts about atomic energy. I make this proposal so that in the months and crucial years ahead it can continue to be said as it has in the past that the glory of the American system is that the common sense judgment of the people as a whole determines the course of the Republic.

THE BOMB AND ATOMIC ENERGY NOT SYNONYMOUS

What do you think of when you think of atomic energy? The chances are that you think only of the atomic bomb. This is natural enough. You have been fed a publicity diet of almost nothing else but horror stories since the blast at Hiroshima two years ago. Some people are warning you to get ready to move into caves. Others are actually proposing, as a defense measure, that we prepare to turn the life of the country over to military control; and other such proposals are being urged. It is a tribute to the American people's horse sense that they have kept their shirts on through all of this. You are troubled, of course, concerned, uneasy—and you should be. The atomic weapon is real. I live with it, day and night, and I assure you that however fantastic, it is plenty real. But scaring the daylights out of everyone so no one can think, inducing hysteria and unreasoning fear—this is not going to get us anywhere—anywhere we want to go.

Now it is perfectly true that atomic energy produces a weapon of unimaginably destructive power. It is true that this nation's Atomic Energy Commission is today designing, developing and producing such weapons. As required by law we fully intend to maintain American preeminence in these weapons until effective international safeguards are in force. It is true that our present monopoly in the production of such weapons will not last indefinitely, and that in time other nations on their own can produce such bombs. It is true that a war in which such bombs were used in numbers would be a catastrophe of unendurable violence to civilization. It is for these reasons that in the United Nations this and other nations have made and continue to make efforts to place atomic weapons under international controls—workable, foolproof controls—efforts which are thus far not successful.

No one—least of all your speaker—underestimates the importance of atomic energy as a weapon, as a weapon that has shaken previous military and diplomatic concepts to their foundations. These facts are just as important to you right here along the peaceful shaded streets of Crawfordsville, Indiana, as they are to anyone in Washington, or London or Paris or Moscow.

But it is equally important to understand that *atomic energy and atomic bombs are not synonymous.* To continue to think so, as most people do, is a major fallacy, a fallacy that will make more difficult our efforts to eliminate atomic energy as a weapon of war, a fallacy that may keep us from the beneficial fruits of this great discovery.

The weapon is the first demonstration of the use of atomic energy, and a very dramatic one it is indeed. But what we have here actually is not simply a weapon. Here is newly acquired knowledge of great and universal forces comparable to the forces of gravity and the forces of electric charges and of magnetism.

I suppose there is nothing of a physical nature that is more friendly to man, or more necessary to his well-being than the sun. From the sun you and I get every bit of our energy, chemical energy—the energy that gives life and sustains life, the energy that builds skyscrapers, and churches, that writes poems and symphonies. The sun is the friend of man. In its rays is the magic stuff of life itself.

As familiar as all of this is to every one of us, it is very close to the subject of atomic energy. For the life-giving sun is itself a huge atomic energy factory. The energy the sun pours forth—that energy has its origin in a process within the sun by which there is released for our benefit the forces within the atomic nucleus, within the atom of the familiar substance known as hydrogen. The sun, I repeat, is an atomic energy plant.

The forces, then, within the atom are not new. Far from it. Without the atomic energy released by the sun, this country would be a lifeless crater.

What *is* new is this: that in our day, our generation, knowledge has so increased, that we are now actually on the long road to understanding atomic energy and making it serve men's needs.

WHAT CHANGES WILL ARISE FROM OUR NEW KNOWLEDGE?

These atomic forces are still not well understood by even the most learned scientists. But here are two towering facts of greatest importance to every living human being the world over:

First: Mankind has probably learned more in the past thirty years about atomic forces than in all the preceding centuries.

Second: Within the next few years —a decade perhaps—we should be in a position to unlock new knowledge about life and matter so great that wholly new concepts of human life will follow in the wake of this new knowledge.

Just as the sun is fundamental to human life, so are the forces within the atom. It is our fortune, yours and mine, and that of our children, to live in that fragment of historical time when knowledge of the very cornerstone and foundation of life may be opened to human understanding.

Let me repeat: atomic science and atomic bombs are not synonymous. That is why I have spoken to you about the sun. The atomic bomb is just one manifestation of atomic energy; the energy in the rays of the sun is another. One is destructive, the other benign and a source of life and strength.

I had another purpose in beginning with the sun. I wanted to make plain that what we are dealing with in the forces of the atomic nucleus are fundamental, basic, and have an effect on everyone's life, as do the nuclear transformations within the sun. Atomic energy is not just another new gadget, nor just a new weapon, however powerful and devastating. We are dealing with forces as fundamental to your life as the force of the sun, the forces of gravity, the forces of magnetism.

Such new knowledge inevitably brings changes. These are changes that will affect you and yours, in your life here in this community. Some of these changes are in process at this moment. Thus the atomic weapon has changed the relations between nations and the problem of the maintenance of peace—and nothing could be closer to your life and that of your children than that. Atomic energy has already brought changes in the treatment of human suffering, and is at this moment adding to knowledge to be used in fighting cancer, heart ailments, and many other diseases.

Radioactive materials from the Commission's plant at Oak Ridge are throwing a clear light upon some of the oldest mysteries of life. For example, how does a stalk of growing corn use the rays of the sun to manufacture its products into energy-giving food substances? How does a plant absorb fertilizer from the soil, and just what happens within the plant? Much progress has already been made through the availability of these radioactive tracers. It is fair to say that the entire investment in the atomic energy project—now nearly two and a half billion dollars—may be more than repaid by the benefits to agriculture and to human nutrition alone. Atomic treatment of familiar metals, and new knowledge of little known metals opens up great prospects in industry. At Commission laboratories work proceeds so that some day the energy released by the splitting of the atoms of uranium and plutonium, will provide a new source of electricity and heat. New professions for your young people, new hope for the afflicted, new understanding of how science can serve for peace—these are among the items on the agenda of the present and immediate future.

But these things—and many others I might mention—are but a beginning. The door of knowledge is but barely opened. No one can predict just what changes will come of knowledge that goes to the root of all things physical. For bear in mind that every living being is composed of atoms, and the nuclear forces we are talking about are within each of these atoms. Remember too that every bit of matter, this desk, the walls of this chapel, the mountains and the seas are likewise composed of atoms and their nuclei. We are therefore throwing light upon the very nature of the structure of the world we live in. What is important to understand is not just what the precise effect of knowledge of these basic forces will be—which is necessarily speculative—but rather that important changes will come—which is as certain as anything in this world can be.

The primitive man who first beheld fire was probably terrified by this strange and destructive force he knew so little about. He could not predict that fire would change the life of every mortal from that early day to this, nor could he possibly know that the forces that he saw lay waste the forest and consume his enemies would someday be accepted as one of the most friendly and helpful forces at man's command.

What should concern us, it seems to me, is not that changes are coming. Americans have always taken change in their stride; indeed generally speaking we thrive on it.

THE PEOPLE MUST DECIDE HOW ATOMIC ENERGY IS USED

What we should be concerned about, and what we should make sure of is that the changes shall be fitted into the American way of doing things, that those changes shall not be so imposed upon us that individual freedom is impaired. We must make sure that the American people will have a say-so, and a decisive say-so, in the adjustments these discoveries will bring in community life, in our agricultural, educational, industrial and military institutions. You must make dead sure that your public servants in all branches of your Government, civil and military, legislative and executive, all understand clearly that atomic energy *is* your business, the people's business.

Now I must warn you that this will not be easy. But it is vitally important to you here in this community and all other communities, large and small, that you keep the

decisions, the broad decisions in your hands. For science and technical matters will become more and more important, important in determining peace and security, important in industry and jobs, in health, in farming, in education, in community affairs here in Crawfordsville and in thousands of cities and towns and villages all through the country. More and more things of your daily life, and in the factory and school and farm will be affected by the discoveries and applications of science. Atomic science will stimulate a whole new world of other discoveries; this is already happening and it will continue. And it can be made pretty much to the good—good for you here in your town, good for peace and decency and human freedom. But you must not at your peril let these new technical advances get out of your power to control and direct. I warn you that this must not happen or the essence of the American scheme of things will be lost.

WHAT USE WILL WE MAKE OF OUR NEW KNOWLEDGE?

It comes down to this, the whole problem of atomic energy, and of all the great scientific discoveries it is bound to bring—it comes down to this:

First: We must persist until we find ways whereby mankind will not make use of these discoveries for destructive and evil ends;

Second (and closely related to the first): We must find ways of encouraging and stimulating the application of these discoveries and new ones to come, to things that are beneficial and helpful to mankind and to the best of human aspirations.

To what *use* will we put this great new ever-growing knowledge? *There* is the real question—to what purpose, to what ends will atomic energy and the fruits of scientific discovery be put?

My friends of Crawfordsville, my fellow citizens of all the peace-loving communities of the wide world, here is the challenge of our time.

These are not scientific matters. What this vast problem requires is not technical judgment, but rather the human experience and good sense of the natural leaders of opinion within the thousands of communities of the country. There has never been any good substitute for the all-around common sense of an informed lay public. That is just what is needed here.

But you can be barred from a decisive voice in these issues about atomic science, issues so close to your life and your future. You can be kept out by your own default—by failing to inform yourselves, so that you will not be able to be effective in the making of the great decisions on the problems that atomic science presents for determination.

There are many reasons why you need to know and understand the basic facts of atomic energy. But none is more pressing than this: that it is those basic facts that determine whether a particular proposal for international control is workable, one that, in the language of Secretary Marshall last Wednesday, will "remove the specter of a war of annihilation"; or whether the facts of atomic energy show that a particular proposal is ineffective and indeed a "fraud on the peoples of the world". It is the facts and an understanding of those facts that determined the American proposal, the Baruch plan, now carried forward by Mr. Frederick Osborn, a proposal which the representatives of the nations have approved.

Now just what is it that you can do about becoming informed, right here in Crawfordsville, and in Galesburg and in Sioux City, in Hartford and Ypsilanti and Fresno and all the other communities of the country?

Bear in mind, what is needed is not knowledge and judgment about scientific or engineering matters—you don't have that and couldn't take the time to acquire it of course. The technical forces associated with the Atomic Energy Commission can do that, and are doing a good job of it, and one you will be proud of. The quality of that job is being constantly checked by independent advisory boards of distinguished scientists. But the kind of judgment that I am talking about is of quite a different sort—for example, a sense of what things people will accept as right and sensible and workable. What is needed is sense about human relations, about standards of fairness, about principles of self-government and of self-education. These judgments turn on the weight to be given to concern for the individual as compared to concern for the state. The issues call for the kind of *over-all judgment* that is summed up when your neighbor says: "That makes sense to me."

Nothing could weaken the security of our country in the atomic field more quickly, nor more surely slow up research in cancer control, say, than to permit science and scientists to be kicked around by the organized forces of ignorance and demagoguery, and petty politics. You don't have to have scientific training to sense that this would be bad, bad for you, bad for Crawfordsville, bad for the country. This sort of thing is a real danger to our scientific progress, for as the old Hoosier saying has it, "There are some men who would play peanut politics with the multiplication table and the Ten Commandments." There is only one real protection against the harm selfish and ignorant and fanatical men can do and that is an informed public.

There are many other broad issues where your judgment will be essential, and your interest vital. These might include such matters as the proposals for international control of atomic weapons; the conditions under which the present Government monopoly in this field can safely be changed to private competitive production; the share of the national budget that should be devoted to scientific research; the adequacy of protection against health hazards from radioactive materials in the air and on the ground; the proper relation of civilian direction to the military, in this field; what kind and size of navy, army and air force we need in the light of developments in scientific warfare; what sense the proposals make that we go underground; the workability of decentralization of cities as a defense measure; how rapidly atomic fuel may supplement coal, oil and water power as a source of electricity; the wisdom and workability of censorship of the press and radio as a means of maintaining secrecy in this field, under peacetime conditions. Such a list of policy issues could be extended almost indefinitely.

THE PUBLIC MUST KEEP ITSELF INFORMED

You need to watch your public servants, to keep an eye on us, whether in the Executive Branch, the military, or in Congress. And to do so effectively your views and judgments must be based upon some knowledge of the background of facts.

How can you acquire sufficient information to make you effective? I have some suggestions to offer along this line.

As to *what* you should know, remember that the information you need to have is not secret technical information. Nor is it highly complicated. The essentials of atomic energy even on the scientific side, are actually not difficult, not nearly as difficult as those who would like to keep the decisions to themselves would lead you to believe.

HOW TO GET THE NECESSARY KNOWLEDGE

For what technical information you need try your nearby colleges or your local high schools—and if their science teachers don't know enough about the subject to be able to explain it simply to the average layman, then you know there is something wrong with the teaching going on around you—and that is worth something in itself. As for the public issues, there too the colleges and the schools can assemble and boil down the relevant facts for the use of your civic organizations.

In providing information about atomic energy the United States Atomic Energy Commission has a responsibility, imposed by law. It is our hope that it can be discharged with good sense and restraint. A considerable area of technical and other information must and will be kept secret under present conditions, and elaborate precautions are being taken to this end. The Commission must provide some guidance on such matters, of course, and will from time to time be prepared to release new information that can be made public without prejudice to security. But by and large, the sources of information on public issues are already open. Much of the information has already been published.

The problem is chiefly one of getting non-secret information into a form for your consideration that will be clear, interesting, and without bias. And for this you can properly expect great things of the press of the United States, the radio and the magazines. These, together with motion pictures, constitute one of the greatest educational forces in human history. There has never been anything like it. The press, the radio and the magazines are competent to take the body of knowledge that exists and with their great skills of presentation make this subject clear and alive for every school child, and every grown-up in your community and all the communities of America. In our great pictorial magazines the country has an unique asset for the presenting of information in graphic form. Similarly with other magazines —those addressed to groups of which you now have local entities here in your town—the national magazine of the Elks, the Rotarians, the American Legion and the other organizations in your community.

It is important that the facts and analysis of policies should come to you from a *variety of sources*, not from only one, and above all that they should *not* come solely from official sources. This variety gives you a chance to check one version against another, and draw your own conclusions.

Such help as this from the outside is necessary, and can be very useful. But try to keep this as close to home as possible, when you come to your analysis and your discussion of these things. Don't be content to take ideas that have been pre-digested for you at some distant place. Put this on the programs of your Chamber of Commerce, the Boy Scouts and Girl Scouts, the Unions, the Parent-Teachers Association, Rotary, Kiwanis, Lions and similar organizations, the League of Women Voters, your Montgomery County Farm Bureau and 4-H Clubs, the local veterans organizations, the business and professional women's organization, the bar association and county medical society —and so on. These are your organizations. You can speak your mind in your own town.

You don't need a brand new organization for this purpose. Make use of the many fine civic, fraternal, educational, professional, and religious organizations you now have in your community.

Don't make this a crusade, a "drive", full of ardor and zing for a couple of weeks and then it's all over. This is not a "campaign." This subject will be with you for a long time, so take it in your stride, as part of your community responsibilities.

What I am proposing here tonight —and will continue to urge—is not that you or any other community start a new organization, and certainly not that this be regarded as a "movement." My hope is that the people of the country will come to be familiar with this new realm of facts and ideas that are so important to us all. I can see the time not long off when the terms Geiger counter, radioisotopes, the Baruch plan, alpha particles, neutron absorption, nuclear reactor—these will become just as much a part of common speech and common understanding as carburetor, X-ray, high octane, short-circuit, and frequency modulation have become in other fields.

What I propose will mean some work. No doubt of that. Most of you are already about as busy as you can be, and those of you who are looked up to as leaders in your community are usually quite burdened with chores beyond your own business and home. Some of this will require reading, discussion, meetings, added to everything you have.

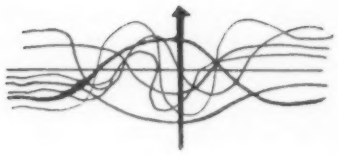
Let me say this: Look upon this task of becoming familiar with the essentials of atomic energy as an obligation directly to your children—and if there are grandchildren, to your grandchildren; or to those nice likeable youngsters next door. This is at least as direct a way of doing your duty to your children as the sacrifices you make without hesitation to get them an education, or the right diet and good doctors. If schemers or fools or rascals or hysterical stuffed shirts get this thing out of your hands—it may then be too late to find out what it is all about. Do this for your children.

Anyway, that idea helps me on my own job; that idea, and the feeling I have deep in me that God the Father of us all did not make man in His image and endow him with capacity to learn nature's secrets in order that man use that knowledge to destroy the human race.

CALAMITY OR PROGRESS?

The American people, talking these things over in all the Crawfordsvilles of this broad land, will get a feel for this subject, an understanding of the essentials of this new force that may make the difference between calamity and progress. I believe the American people, thinking it over together in their home towns, and having it on their hearts, will work this thing out and make good sense of it. For in the conscience and the judgment of the people lies the strength of democracy.

ATOMIC ENERGY AND AMERICAN INDUSTRY



David E. Lilienthal

Speaking before the Economic Club of Detroit on October 6, Mr. Lilienthal addressed American industry as a whole on its vital stake in the development of atomic energy. We give below a condensed version of these remarks. The main section omitted fills in the technical background with data already familiar to many BULLETIN readers and stresses the contribution required from industry at every stage. While in Detroit Mr. Lilienthal announced the appointment of an industrial advisory board as reported on page 342.

. . . Let me say at the outset that in our opinion the long-time prospects of atomic power are bright indeed. America's leadership in atomic energy research and production is one of our nation's great assets.

But the fact should be faced squarely that the first commercially practical atomic power plant is NOT just around the corner, not around two corners. Before that first commercial plant will be possible we must first cut through a jungle of difficult scientific and engineering problems. And even after the scientific and engineering underbrush has been cleared away, and a commercially useful plant of some size is in successful operation, there are other barriers that must be overcome before any substantial part of our energy supply—say 10 to 20%—comes from atomic energy.

This does not mean that within the next twelve to twenty-four months useful electric power could not be actually developed from a nuclear reactor, that is to say, from atomic energy. Such atomic power could turn motors and light bulbs, and heat buildings. As a matter of fact, on a demonstration basis (a thousand killowatts or so) that could certainly be done. Indeed that almost certainly *will* be done. But what is certainly and definitely NOT near at hand are large-scale, practical commercial applications of power from atomic energy.

Now of course the economics of power production from nuclear reactors cannot be divorced from the scientific and engineering problems. But this is not economics as we usually use the term, that is, a comparative analysis of the costs of producing power from one type of fuel as opposed to another. There is as yet *no firm basis for estimating competitive cost position* of useful power from nuclear sources with respect to the cost of generating power from conventional fuels. . . . .

SCOPE OF OPPORTUNITY AND PARTICIPATION

The subject I have chosen to discuss here today—Atomic Energy and American Industry—is obviously far broader than the prospects for atomic power. The subject embraces issues concerned with the military use of atomic energy, such as current proposals for decentralization of cities and location of industry underground. The subject includes the whole field of industrial and business opportunities in this field. These include the possibility of manufacture and sale by private industry of molecular compounds containing radioactive and stable isotopes, among them carbon, substances now produced in some quantities at Oak Ridge. It includes the possibilities of the use of such radioactive tracers in industrial chemical process control and research problems, and in oil well surveys throughout the petroleum industry, as well as in hydrocarbon cracking, processes for research and control. The subject includes the steps the Commission has already taken, and others it will shortly take, to insure industrial and engineering participation, from the very beginning, in the design of power reactors. It includes the whole attractive outlook in the use of reactors producing beams of very high neutron intensity for the treatment of many kinds of materials, among them metals. This may open a new era in metals for industry. It includes the training of engineers and industrial men generally in these new fields, so that American industry can keep abreast of developments as they occur, and in this way help protect against any tendency toward inertia and complacency that the existence of the present Government monopoly may bring with it, for this inertia is an always present danger with most monopolies, governmental or private.

I mention these matters to illustrate by a few cases how broad and inclusive is American industry's stake in the course of atomic energy development . . .

It ought to be said, rather bluntly, that unless American industry and American engineering skills become an active living part of the Atomic Energy Commission's undertaking, the expectations and the needs of this country in this field will be inevitably doomed to disappointment.

There is a very real difficulty in achieving the active widespread participation of American industry and engineering in atomic energy development that is so essential. That difficulty is the continued need for secrecy in important sectors of this work . . .

Secrecy and industrial progress are not cut out of the same cloth. Government-imposed restrictions upon access to information about atomic energy development are not calculated to invite and encourage that ferment of ideas, that self-criticism, that competition, that cross fertilization between skills that has given America its industrial strength and vigor . . .

The Commission certainly believes that this atomic industry can never flourish and grow and find its proper place among the elements of our national strength unless it sends its roots deep and wide into the same soil that has nourished the automotive and other industrial giants, the soil of competitive private industry . . .

SPECIFIC PROBLEMS ENUMERATED

There are at least four elements to the problem of making atomic power a practical reality. One is to get energy in a useable form, which probably means in the form of high temperature heat. Second is to have a reasonable rate of generation of power per unit of nuclear fuel invested. By nuclear fuel I mean of course some form of uranium and plutonium. Third is to have adequate stocks of such fuel to activate a sizeable atomic power industry. Fourth is to prevent wastage or loss of this precious fuel in the complex business of handling it.

To state all of the difficulties in any detail is not now possible, for the obvious reason that some of them lie close to those of providing the materials of atomic weapons. What I can do is therefore limited to giving you a few important and typical examples of the technical problems that we face.

Let us look briefly at a few of these typical problems.

Low temperature energy not directly used for power production is now generated at Hanford, the plutonium factory, from natural uranium metal. But the Hanford reactors were built for the prime purpose of manufacturing plutonium. The energy they yield in the form of heat is merely a nuisance. It is sent down the drain into the Columbia River.

When useful power and not plutonium is the prime objective, we face a host of problems for which the Hanford experience offers no answers.

Aside from the fissionable materials —uranium 235 and plutonium—which may be the energy sources in a reactor, the reactor itself calls for materials of construction. . . .

Before we can go forward with an atomic power industry the properties of the few possible materials must be known — their metallurgy, strength, corrosive properties and the like—all under the conditions of the fantastically intense radiation which exists in a reactor. These properties of materials must be studied and understood in the same sense that the properties of steel have been studied and understood for the uses to which steel is put.

If atomic energy released in the form of heat is to be converted to industrial energy with any reasonable efficiency, the source of heat—the nuclear reactor—has to run at a reasonably high temperature. This is an inescapable fact of science and engineering. This means that all our materials must be chosen and designed to endure the stresses that go with such temperatures. For the special and rather little known materials which seem likely to be adapted to such a reactor, the mechanical and thermal properties are not known. This knowledge we must have before real headway will be made.

This catalogue of problems is already long; there are others which may be the toughest of all.

When fission takes place energy is released. Additional neutrons are given off in the fission process. These neutrons produce fission in other nuclei. This is the familiar chain reaction. But something is left behind, the result of the splitting of the nucleus. This mixture of the isotopes of many elements are very radioactive. Inside the reactor, where all this takes place the effect of these "hot" elements on the operation of the reactor is bad. Some of the new elements absorb neutrons readily, so that their effect is to quench the nuclear reaction. The fission products —the nuclear ashes—must be removed and the remaining nuclear fuel recovered to be used again. This is a chemical separation job that presents some highly complex and difficult problems of chemistry, chemical engineering and metallurgy — and it must be carried out by remote control to protect the workers from the lethal radiations. I need not stress the troubles of this kind of operation by mechanical proxy, nor need I stress the economic importance of efficient recovery of the unspent nuclear fuel, for this is material that may not under any circumstances be wasted.

Until these many problems have been worked over, hard, we do not have a good basis for the engineering design of an atomic power plant. In Commission laboratories over the country, and in industrial laboratories and institutions, these problems are being studied. The ultimate objective is a reactor to operate at a rather high temperature. From such a reactor useful power will be extracted, *but* this reactor will use an expensive form of nuclear fuel—plutonium or the rare enriched uranium, U235—in all probability. For all but very special uses, this fact puts a high premium on efficient processes for separating the radioactive poisonous fission ashes from the unused nuclear material. And these have yet to be developed, although the work is now under way . . .

PROSPECTS FOR ATOMIC POWER

I can . . . say explicitly a thing which probably is already obvious to you from all that I have said before. This is: there is not any reason to expect that an atomic energy industry will spring into being overnight and make its appearance as a colossus upon the national scene, displacing at once the power industries which now serve us and disrupting in a few years the whole pattern of our economy. It will almost certainly follow the course of supplementing rather than supplanting existing economical sources of energy supply. Our judgment is that clearly no one should delay sound and economical additions to power supply, whether by fuel-generated electricity or water power, because somewhere in the future atomic energy will come on the scene as an additional source of supply. There will certainly be ample time to make whatever adjustments may be needed.

The Atomic Energy Commission pledges that American industry and engineering will be kept informed of developments in this field. When, as in this discussion, the information cannot be complete, we will tell you so. Atomic energy is your business, the people's business, and you have a right to know. More than that, unless industry does know, and unless it is a participant, atomic energy development will suffer, and we shall have failed in our obligation to the public.

AN INTRODUCTION TO THE PROBLEM OF GUIDED MISSILES

Lawrence R. Hafstad

Dr. Hafstad discusses the scientific approach to a dramatic phase of modern armaments. The author is on leave as Director of the Applied Physics Laboratory, Johns Hopkins University while he serves as Executive Secretary of the Research and Development Board.

There is little doubt that one of the most striking features of the war just finished was the "total war" aspect of hostilities. Industry supported the military as never before. In active theatres, civilian and soldier alike were exposed to danger and both contributed to the common defense, as the battles of London and Stalingrad convincingly demonstrated. Scientists, too, though normally retiring and peace-loving people, had their contributions to make.

Credit for the various gadgets developed by the scientific fraternity during the war has been generously given by military men. But they know, and we know, that the war was mainly fought and won with the weapons available at the beginning of the war. We had developed an imposing array of "trick devices" by V-J Day, but how much better it would have been, how many lives and how much money could have been saved had these devices been ready at the start of hostilities! If there is another war, all indications show that it will be shorter, more violent, and "much faster breaking" than those of the past. Only that nation can survive which is adequately prepared for just that kind of war. Next time the gadgets must be ready when the shooting starts.

To attain this end the military and the scientists must work together in peacetime as well as they did during the war. This will be much more difficult, as all experienced administrators know, without the persuasive influence of obvious and immediate common danger. Differences of opinion which were brushed aside in a single conference under wartime pressures will fester for weeks or months in the more selfish peacetime atmosphere. The free-ranging mind of the scientist, thoroughly trained to question all dogma and any authority, is going to collide head-on with the convenient system of channelled thinking necessary for military teamwork.

In military research a determined effort will be needed to maintain mutual respect and confidence, and an almost infinite amount of tolerance and patience will be required of both military and scientific men.

BROAD PERSPECTIVE IS REQUIRED

In approaching the problems of guided missiles it is of primary importance to get a broad view of the entire field. Perspective is needed for judgment, and since our technical knowledge is inadequate, good judgment is going to be needed above all else in solving guided missiles problems.

Though we will highlight inherent difficulties, this does not mean that there is need for discouragement. Good progress is being made, and the post V-J fog of confusion is gradually lifting.

No doubt we are being visionary, too much influenced by Sunday supplement stories, when we consider the implications of the very long-range missiles. Instead, let us consider a *simple* guided missile. Let us put control surfaces on an air-launched bomb and guide it, just a little, into a designated target. In this case we have no navigational problems, no large acceleration forces at launching, and we can utilize human intelligence to a large extent in locating and choosing a specific target.

But even in this case the problem is extremely difficult, as was quickly learned by the enthusiastic group who several years ago attacked these "simple" problems. Even subsonic glide bombs put a strain on our knowledge of aerodynamics and other essential design factors, and forced us into a slow and costly empirical program. To this, add the fact that space limitations in a more sophisticated missile compel us to develop completely new electrical and mechanical control mechanisms, and also that these new and unperfected mechanisms are subject to unknown and unobservable forces and vibrations in free space, miles away from the men who are trying to diagnose the troubles, and you begin to see what the difficulties in making guided missiles really are. Years have gone into the development of the lumbering prototype of the guided missile known as the torpedo. Aerial guided missiles combine and extend all the problems of both developments, yet in some quarters it seems to be expected that usable "hardware" can be delivered in months instead of years.

RESEARCH MUST COVER MANY FIELDS

In neither my civilian nor my military experience have I seen a problem which includes so many branches of physical science. Aerodynamics, radar, electronics, telemetering, servo-mechanisms, gyros, computers, thermodynamics, combustion, metallurgy, propulsion, and chemistry must all contribute to a successful guided missile. Nor are these contributions by any means routine, but are new ones representing real advances of the art in each field. It is for this reason that many of us firmly believe that guided missiles problems must be approached from the research rather than the design point of view.

Research has been defined as the effort of the mind to comprehend relationships which *no one has previously known*. It is this individualistic aspect of research that makes it almost impossible to "plan" in the conventional sense. No one can schedule in advance the dates on which ideas will crystallize into solutions of baffling problems. It is for this reason that research involves a large element of uncertainty or risk. In research one learns from failures, and any individual with the necessary "spark" or inspiration is undismayed by failure so long as knowledge accumulates. In research failures are taken for granted; in engineering a failure is a mark of incompetence.

Research is doing something different for the first time, not making something bigger or better or cheaper —that is usually what is meant by engineering. Of course, there are research engineers, and they have a real part to play; but they think, react, and behave like their scientific colleagues, and for the purposes of our discussion must be classed as scientists.

Many military men had experience during the war in trying to referee fights between research departments and production departments, often within a single industrial company. To the uninitiated the difference in points of view can be startling. It may be helpful if we try to indicate why and how the differences of opinion arise.

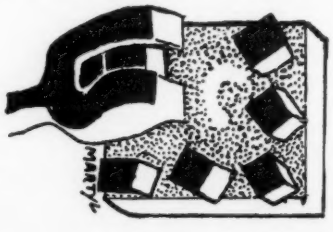
RESEARCH AND ENGINEERING

In any new development there is a period of apparent floundering, politely dignified by the name of research, then a period of rapid improvement, and finally a period of painfully slow gain as perfection is approached. During the research phase there is nothing to do except build apparatus according to some individual's hunches. Lacking technical facts on which to base decisions, official conferences are fruitless, for one man's opinion is as good as another's. Chances of success in any one test are extremely small; hence the element of gamble. As Conant has said, "There is only one way to do basic research and that is to pick a good man and back him heavily."

Once a single success has been achieved the picture changes completely. The element of chance is effectively removed; blind and abiding faith is no longer essential; skeptics hasten to jump on the bandwagon; purse strings are loosened; and a period of rapid development ensues. This first success seems all-important to the researcher, in fact he usually feels then that the job is done and looks for new fields to conquer. To the ultimate user and to the production engineer the job has just been started. The latter in fact will usually imply that he knew all the time that the job could be done; that he could have done it more quickly and cheaply; and that he should have been consulted in the first place. These conflicts are unavoidable and are no reflection on the personnel in either group.

There is, of course, a good deal of truth on both sides. It is clear how much remains to be done after the research phase is finished. This is the picture the development and production engineer sees. However, the same information can be presented in another way, and another side of the picture comes into focus. Here the tremendous importance of a first achievement is emphasized and all the tedious labor of perfecting a device is relegated to a polishing operation. This is the situation as seen by the scientist or research engineer.

Normally, industry can afford to lag far enough behind pure science to allow time for the basic research to get done, even though the effort expended in this region is relatively small. From the last war, however, we have learned that military developments cannot follow too hard upon the heels of scientific discoveries. Guided missiles problems fall in the middle at the basic research point. This is demonstrated by the familiar difficulty in the guided missiles field of getting "hardware" out of either industrial or university contractors. It is significant, too, that there has been little new hardware of any kind delivered to the services in these past two years. Gravity-powered missiles are still the only operational weapons. Neither industrial nor university groups are at present prepared to do the whole job, simply because there is still no source of basic information on which the designs must be based.



A.E.C. APPOINTS INDUSTRIAL BOARD

To speed up industrial opportunities in the Atomic Energy field including the development of atomic power plants, the United States Atomic Energy Commission announced on October 6 the information of a Board of Consultants to include industrial leaders in a number of business fields. James W. Parker, President and General Manager of the Detroit Edison Company is to be Chairman of the new group of consultants.

Among other industrial leaders invited to assist the Commission in accelerating business opportunities, including power, are:

O. E. Buckley, resident, Bell Telephone Laboratories, New York, N. Y.;

Donald Carpenter, Vice President, Remington Arms Company, Bridgeport, Conn.;

Dr. Gustav Egloff, Director of Research, Universal Oil Company, Chicago, Ill.;

Paul Foote, Exec. Vice President, Gulf Research and Development Company, Pittsburgh, Penna.;

Robert G. Wilson, Chairman of the Board, Standard Oil Company of Indiana, Chicago, Ill.;

Col. Walker Cisler, Chief Engineer of Power Plant, the Detroit Edison Company, who will serve as Exec. Secretary to the consultant group. He is presently acting consultant to the Commission.

Chairman David E. Lilienthal stated that the Consulting Board had two initial purposes: to aid the Atomic Energy Commission in making rapid headway towards the earliest possible practical application of atomic energy by private business, and to place the consultants in a position, within security limitations, to keep American industry informed of developments in the Commission's widespread activities of research development.

HEISENBERG ON THE GERMAN URANIUM PROJECT

S. A. Goudsmit

In the course of several months spent in Germany on a War Department mission Dr. Goudsmit investigated the status of German science and scientists. He now comments briefly on a subject to be discussed at length in his forthcoming book, ALSOS. Dr. Goudsmit is now Professor of Physics at Northwestern University.

In a lengthy article in *Nature*, Germany's foremost physicist, Werner Heisenberg, describes the German effort on the uranium problem. The article is a translation of a report intended for *Die Naturwissenschaften*, a circumstance that may well explain some of the surprising features of Heisenberg's discussion. It has all the earmarks of being meant for German home consumption and home appeasement.

During the war the Nazis promised the German people all sorts of superweapons to defeat the Allies. Among them was an atom bomb. In the early pile experiments in Leipzig, the metallic uranium powder caught fire and the fire department was called in. The firemen congratulated Heisenberg and his co-workers upon their apparent success in producing an atomic explosive.

On another occasion a member of the SS complained to his superiors that Germany did not work hard enough on a uranium bomb. This was answered in November 1944 by Professor Gerlach who was then in charge of the German uranium project. He stated in a top secret report that the ideas of the SS man were indeed closely related to the work performed on the project. He also pointed out that both theory and experiment showed that it was impossible to construct a small bomb as at least several tons of material were needed.

The SS kept close track of the work. When one of the German pile laboratories was about to fall into the hands of advancing American troops the SS picked up scientists, material, and equipment and moved them at the last moment to the "Bavarian Redoubt". There the scientists were ordered to continue their uranium research.

The German scientists themselves were at all times convinced that they were on the right track and well ahead of American developments. They stated so on several occasions. In a letter to Goering's staff in July 1943 the chief of Germany's civilian research writes: "The work has progressed rather considerably...Though it will not lead in a short time towards the production of useful engines or explosives, it gives, on the other hand, the certainty that in this field the enemy powers cannot have any surprise in store for us."

As late as December 1944 Professor Gerlach wrote to Nazi leader Bormann that these researches "could unexpectedly become of an importance decisive for the outcome of the war... I am convinced that we, at present, are still considerably ahead of America."

German documents indicate that their scientists did not have the correct concept of an atomic bomb. They did not hit upon the idea of using a uranium pile for the production of plutonium and of making this new substance into a small bomb. Their notion of a bomb never went beyond the erroneous concept of an explosive pile, similar to the initial idea of the Allied scientists. We now know that such a "bomb", apart from its prohibitive size, would not have been an effective explosive.

Thus it is clear that the German scientists were more than just surprised when the news of Hiroshima reached them. They were immediately put on the defensive. They had to explain why the supposedly superior German science had failed in this undertaking. Heisenberg's German "Smyth Report" is his answer to the German people.

The true reasons for the German failure[1] can probably be summarized in two statements. First, the German scientists lacked the vision necessary for the successful completion of such a task; they misunderstood many of its aspects. Secondly, the totalitarian regime was detrimental to the progress of pure science in general.

If one reads Heisenberg's report, quite a different impression is gained. Nowhere in his long article does he blame the Nazi regime for its fatal interference with German science. He merely states timidly that "public interest in atomic physics was negligibly small in Germany between the years 1933 and 1939." Was it pure coincidence that during those years that same "public interest" prohibited the teaching of Einstein's theory and that books were written against modern physics?

Heisenberg's report is a tale of success. The German public is led to believe that their scientists were as well on their way toward reaching the goal as the Allies. It is true that some of the German measurements were of high quality. Their scientists might perhaps have had a low energy pile operating if the war had lasted one or two years longer. But they were on the wrong path as far as the bomb was concerned. It is not right to blame this on a ruling by Armament Minister Speer or on the war conditions in Germany.

Heisenberg writes that "in the United States, the final decision was taken to go for the production of atomic bombs . . . ; in Germany an attempt was made to solve the problem of a prime mover driven by nuclear energy . . . The mere possibility of solving the problem had been rendered possible by the discovery of the German scientific workers Hahn and Strassmann; and so we could feel satisfied with the hope that the important technical developments, with a peace-time application, which must eventually grow out of their discovery, would likewise find their beginning in Germany, and in due course bear fruit there."

Such statements make the casual reader believe that it was a deliberate decision of the German scientists to refrain from making atom bombs, whereas all the time they themselves thought that they were progressing satisfactorily in that direction.

1. Dr. Goudsmit discusses this failure at some length in his book, *ALSOS*, to be published shortly by Henry Schuman, Inc.

Security in Nuclear Research

(Continued from Page 324)

these fields than under the present uncertain circumstances. Declassification by fields would also remove some of the difficulties of free scientific discussion. The Commission can make such a determination under Section 10, b (1) of the Atomic Energy Act.

Another aspect of the whole problem should not be ignored. The time lag and inconvenience caused by the partial control of information is offset to some extent by large scale support in the processes of accumulating it. Also some specific attempts are being made to remedy the effects of wartime restrictions on the dissemination of knowledge in the field of nuclear research. At Clinton Laboratories, for example, a special training course has been organized. Radioisotope techniques may be learned at several places. At the Massachusetts Institute of Technology special training in nuclear engineering has begun. The Brookhaven Laboratory, which is sponsored by nine leading universities in the different parts of the United States, is conceived by its sponsors and by the Commission to play a role in advanced education as well as research.

As is implied in Mr. Wilson's letter, it is still too early to judge the effect of the Atomic Energy Act on the flow of scientific information. Officially the Commission has been in operation only since the first of the year. Nevertheless, the bureaucratic obstructions and legalistic uncertainties have already worn the nerves of the scientists involved. Papers have been held up for an undue length of time. Declassification has been refused because of ill-applied and misinterpreted regulations. Necessary decisions have been lacking. It is all too obvious that scientific work is adversely affected.

There are however many things to be said in favor of the present arrangement. The scientists are no longer dominated by the military and all controls are established by a Commission of civilians, for the members of which the American scientists have the greatest personal respect. The scientists realize that this Commission is as much bound by an act of Congress as are the scientists themselves. There is no doubt in the minds of American scientists that a general easing of international tensions will result in more liberal security policies.

It is perhaps significant to note here that between the time of the release of the official statement by the Atomic Energy Commission and the date of the completion of this report, the President of the United States announced publicly that radioisotopes, produced in the United States, will be made generally available to research institutions outside the United States. Not only physicists everywhere, but also workers in related fields like chemistry, biology and medicine will be able to profit directly by the program of nuclear research carried on in the United States.

ASSOCIATION OF SCIENTISTS FOR ATOMIC EDUCATION NEWS

PLANS FOR EFFECTIVE EDUCATIONAL WORK

The Association's Board of Directors met in Chicago September 13-14. The status of existing regional educational campaigns was reviewed. The Board decided to proceed immediately with a detailed re-evaluation of the effectiveness of the different types of programs. It was recognized that those fundamental scientific facts which demand that atomic energy be controlled internationally have been presented neither widely nor adequately enough at the conferences of the past (see BULLETIN issue, Vol. 3, No. 7. Although these programs have been successful on a regional basis, future planning will be directed towards the development of a national impact. Mr. Jack L. Balderson of the Southern Regional Council, Oak Ridge, has joined the national staff in the New York office.[1] He is undertaking the staff work in the development of this national program and will be advised by an Educational Planning Committee consisting of E. E. Minett, Chairman, A. A. Brown of the Chesapeake Council, George L. Glasheen, Executive Director of the National Committee on Atomic Information, and Harold L. Oram of the Emergency Committee of Atomic Scientists, Incorporated. Mr. John Thomason, Conference Director of the state conference type of program, will act in an advisory capacity to the Committee.

In order best to use the experience of staff Conference Directors, scientist-speakers, and the resources of the National Committee on Atomic Information, it was felt that the educational conferences should be planned from a national office by a joint ASAE-NCAI staff rather than by each Regional Council of the ASAE. It was felt that the NCAI, representing as it does sixty of the most nationally prominent social organizations, would be able to provide through its local member groups not only large and representative audiences but also ideal media through which continued studies and educational work would proceed.

Reports were made to the Board of two scientific types of programs which have been tested. The present state conference system of holding one-day meetings in each of the cities of over 15,000 population within a state has been reported in a previous issue. Dr. Walter Orr Roberts of the Rocky Mountain Committee on Nuclear Energy reported on an institute type of program. Such a plan was used successfully by the Colorado Town Meeting, Inc. in its "Estes Park Foreign Relations Institute" where a week-long conference was held with people invited from the entire Rocky Mountain region.

The Board directed the Educational Planning Committee to report on its plans for a unified national program at the Board's next meeting to be held in New York City October 25-26.

Walter C. Beard, Jr.

[1] Association of Scientists for Atomic Education, Room 523, 625 Madison Avenue, New York 22.